

-3 MAR 1938  
PRESENTED



# THE LARVAE OF THE DECAPOD CRUSTACEA

## PALAEEMONIDAE AND ALPHEIDAE

BY

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WITH TWO HUNDRED AND SIXTY-FIVE TEXT-FIGURES.

### CONTENTS

PAGE

#### I. PALAEMONIDAE.

##### 1A. PALAEMONINAE.

##### *Leander* Group.

*Leander pacificus*, Stimpson . . . . . 3

*Leander tenuicornis* (Say) . . . . . 4

Palaemonid B.R.I. . . . . 6

##### *Palaemon* Group.

*Brachycarpus biunguiculatus* (Lucas) . . . . . 8

*Retrocaris* . . . . . 9

Palaemonid D. I (*R. spinosa*, Ortm. ?) . . . . . 9

Palaemonid D. II (*R. contraria*, Ortm.) . . . . . 12

DISCUSSION OF THE LARVAE OF PALAEMONINAE . . . . . 14

##### 1B. PONTONINAE . . . . . 15

*Periclimenes* Group . . . . . 16

*Periclimenes grandis* (Stimpson) . . . . . 16

*P. agag*, Kemp . . . . . 16

*P. diversipes*, Kemp . . . . . 17

*Harpilius beaupresi* (Audouin) . . . . . 18

*H. gerlachei*, Nobili . . . . . 20

*Coralliocaris graminea* (Dana) . . . . . 20

Palaemonid R.S. I . . . . . 21

Palaemonid B.R. II . . . . . 22

Palaemonid B.R. III . . . . . 23

Palaemonid D. III . . . . . 24

Palaemonid D. IV . . . . . 25

Palaemonid B.R. IV . . . . . 26

	PAGE
DISCUSSION OF THE PERICLIMENES GROUP . . . . .	27
<i>Mesocaris</i> Group . . . . .	29
Palaemonid B.R. V . . . . .	30
Palaemonid R.S. II . . . . .	31
Palaemonid R.S. III . . . . .	32
Palaemonid R.S. IV . . . . .	33
Palaemonid B.R. VI . . . . .	34
<i>Cryptoleander</i> Group . . . . .	35
Palaemonid B.R. VII . . . . .	36
Palaemonid B.R. VIII . . . . .	38
Palaemonid B.R. IX . . . . .	39
IC. ANCHISTIOIDINAE.	
<i>Anchistioides</i> . . . . .	41
<i>Anchistioides</i> Species I . . . . .	41
<i>Anchistioides</i> Species II . . . . .	42
II. ALPHEIDAE.	
<i>Alpheus ventrosus</i> , M. Edw. . . . .	44
<i>A. audouini</i> , Coutière . . . . .	45
<i>A. pacificus</i> , Dana ? . . . . .	47
<i>Synalpheus triunguiculatus</i> (Paulson) . . . . .	48
Alpheid R.S. I . . . . .	51
Alpheid R.S. II . . . . .	52
Alpheid B.R. I . . . . .	53
<i>Athanas djiboutensis</i> , Coutière . . . . .	54
Alpheid D. I . . . . .	55
<i>Anebocaris ancylifer</i> , Coutière . . . . .	56
Alpheid ? D. II . . . . .	56
RELATION OF PALAEMONIDAE TO ALPHEIDAE . . . . .	58

### I. PALAEMONIDAE.

OUR present knowledge of the larvae of the Palaemonidae is very unsatisfactory. We know fully those of five species of *Leander* (*L. serratus*, *L. squilla*, *L. longirostris*, *L. fabricii*, *L. paucidens*) and of two species of *Palaemonetes*, so that the characters of these two genera are fully established. Sollaud has also described the development of a number of species of *Leander* and *Palaemon* in which the larval stages are more or less suppressed. Of the many genera and species of the Pontoniinae we know only the development of two species of *Periclimenes* of the subgenus *Ancylocaris* (*P. calmani*, *P. americanus*). In addition various larvae taken in plankton have been described under the generic names of *Retrocaris* and *Mesocaris*. Lastly I have been able to describe the early larvae of *Anchistioides antiquensis* (1936) which is regarded by Miss Gordon as a member of the Pontoniinae.

The following report is based upon a large and very varied series of larvae from the plankton of the Great Barrier Reef, and I am much indebted to Mr. F. S. Russell for the privilege of making use of it. In order to make the account as comprehensive as possible

I have brought into consideration also material from Ghardaqa on the Red Sea and also certain specimens from the "Discovery" Expedition.

From this abundant material I have selected for description 17 larval forms which can with some certainty be referred to the Palaemonidae, but cannot be definitely identified. Together they illustrate a variety of form and of structure of appendages which is surprising and raises perplexing problems of systematics.

With our present groundwork of knowledge of the two genera *Leander* and *Periclimenes* it is possible to separate these forms into the two subfamilies Palaemoninae and Pontoniinae, but even so there remains uncertainty in some cases.

The close examination of these larvae shows that the summary I have given of the characters of *Periclimenes* and *Mesocaris* (1936, p. 623) is inadequate, since there are details in the structure of the appendages which should be taken into consideration. The significance of such differences naturally only becomes apparent when the survey can be extended over a sufficiently wide field.

Another point which I have not before fully appreciated is the correct designation of the spines on the anterior part of the carapace in late stages. The homologies of these spines are not always clear. In *Leander* the anterior angle of the carapace is pointed, and this point may be taken as the pterygostomial spine, which is lost at the last moult, and does not appear at all in *Retrocaris* (*Palaemon*?). In *L. serratus* a small spine appears just above and quite close to the pterygostomial point, and is no doubt the branchiostegal spine, which usually persists in the adult and is absent in the adult of *Palaemon*. It is, however, present in the larva if *Retrocaris* is rightly referred to *Palaemon* or *Brachycarpus*. The antennal spine, which is present in the adult of both genera, does not make its appearance in the larva. In *L. paucidens* Yokoya regards a small spine which arises in Stage VI as antennal, but it has the position of the spine which I regard as branchiostegal.

Apparently the branchiostegal spine is found in all larvae of the Palaemoninae and is lost later in *Palaemon* and *Brachycarpus*, while the antennal spine is very rarely developed in larval life.

#### 1A. PALAEMONINAE.

*Leander pacificus*, Stimpson. (Text-figs. 1-7.)

##### LOCALITY.

Common on the tidal reef-flat at Ghardaqa along the mole leading to the laboratory. One female hatched larvae on March 15th.

##### DESCRIPTION.

Stage I. Length 2.75-3.3 mm.

Rostrum reaching end of peduncle of antennule, serrated at end. Abdominal somite 5 without lateral spines. Telson much wider than long, the three inner pairs of spines about equal in length.

Antennal scale long and narrow, segmented at end, the proximal outer seta reduced to a minute hair. Close to the proximal inner seta is a minute tubercle, such as is found more marked in Pontoniids and some Alpheids.

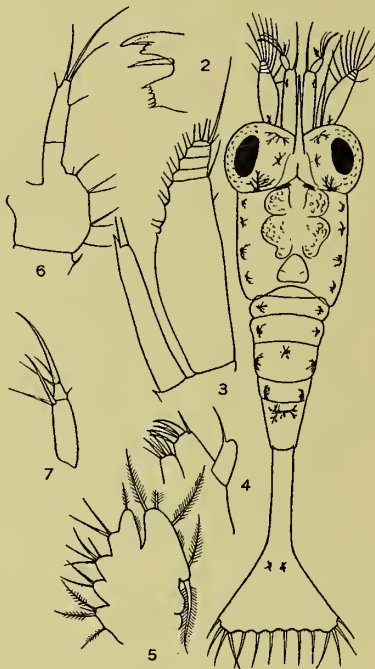
Mandible with one large spine between incisor and molar parts. Maxillule, endopod small, rounded at end, with one subterminal seta; lacinia 2 with four spines. Maxilla, endopod broad, with well-marked basal lobe bearing two setae; exopod with five setae.



Maxillipede 1 with endopod faintly divided into two segments, basis not protuberant, with few small setae; exopod with six setae. Maxillipede 2, basis with three small setae; endopod of three segments; dactyl with large terminal spine and two smaller spines on either side. Maxillipede 3, dactyl with very large terminal spine; without strong spines on basis or ischium. Exopod with eight setae.

Rudiments of legs 1 and 2 biramous.

Colour: General appearance red. Thorax with a row of four dark red chromatophores with yellow branches; a double row of red chromatophores on abdominal somites 1-4. Dark olive chromatophores in base of antennae.



TEXT-FIGS. 1-7.—*Leander pacificus*, Stimpson.

FIG. 1.—Stage I, dorsal.  
FIG. 2.— „ mandible.  
FIG. 3.— „ antenna.  
FIG. 4.— „ maxillule.

FIG. 5.—Stage I, maxilla.  
FIG. 6.— „ maxillipede 1.  
FIG. 7.— „ maxillipede 3.

#### REMARKS.

This larva is of perfectly normal *Leander* type, agreeing in all respects with that of such species as *L. longirostris* and *L. squilla*.

*Leander tenuicornis* (Say). (Text-figs. 8-16.)

#### LOCALITY.

This species is common on the *Halophila*-bed at Ghardaqa, and in floating *Sargassum*. Larvae were hatched in the laboratory on 2nd February and 9th March.

#### DESCRIPTION.

Stage I. Length 2.2-2.5 mm.

Carapace with small median dorsal papilla; rostrum nearly as long as antennule, with a few small denticles dorsally at end.



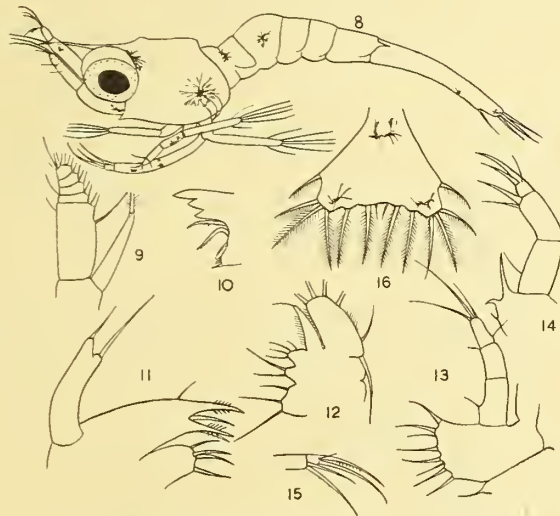
Abdominal somite 5 with lateral spines. Telson broader than long, slightly concave, the innermost pair of spines very small.

Antennule, distal segment with a feathered seta and four aesthetes, of which one is very stout and one seta-like. Antennal scale with four distal segments distinct; two outer and ten inner and apical setae; endopod with a long seta and small spine.

Mandible with three large teeth on incisor part, and three spines in the hollow between it and the molar part.

Maxillule, endopod slender, bilobed at end, and with two setae; lacinia 2 with four spines. Maxilla, endopod slender, without basal lobe or seta; exopod with five setae.

Maxillipede 1, endopod of three distinct segments; coxa very small; basis remarkably produced, axe-shaped, with six strong spines; exopod with four apical setae.



TEXT-FIGS. 8-16.—*Leander tenuicornis* (Say).

FIG. 8.—Stage I, lateral.

FIG. 9.—,, antenna.

FIG. 10.—,, mandible.

FIG. 11.—,, maxillule.

FIG. 12.—,, maxilla.

FIG. 13.—Stage I, maxillipede 1.

FIG. 14.—,, maxillipede 2.

FIG. 15.—,, maxillipede 3, dactyl.

FIG. 16.—,, telson.

Maxillipede 2, basis with two large spines; endopod of three segments, with strong spines on segments 2 and 3.

Maxillipede 3 with strong spine on basis and at position of division between ischium and merus; dactyl with two long slender apical spines. Exopods of maxillipedes 2 and 3 with six apical setae.

Rudiments of legs 1 and 2 present.

Colour: General colour of thorax pinkish yellow; abdomen nearly colourless when chromatophores are contracted. The large chromatophore behind the eye is dark red, with olive-brown branches, and, when the chromatophores are expanded, the general colour becomes red. The chromatophores in the telson and maxillipedes are olive-brown.

Stage II. Length 2.8 mm.

Carapace with large supraorbital and anterior dorsal spines. Telson with 8 + 8 spines, the middle pair unusually small.

Antennal scale segmented, with 15 setae ; endopod unchanged.

Legs 1 and 2 developed, with exopods bearing eight setae ; rudiments of legs 3 and 4 present, very small.

Additional chromatophores have appeared in thorax and abdomen.

A few specimens moulted to Stage II in the laboratory ; but neither this nor any later stages were found in the plankton.

#### REMARKS.

While the larva has most of the characters usual in *Leander*, the mouth-parts differ considerably. The form of the endopod in maxillule and maxilla, and of the basis in maxillipede 1 is quite unlike that of the normal type, and the presence of strong spines on the basis of maxillipede 2 is a feature unknown in *Leander*, but found again in some Pontoniids. The long slender spines on maxillipede 3 are also seen in some Pontoniids, and not in *Leander*.

Palaemonid B.R. I (*Leander* sp. ?). (Text-figs. 17-24.)

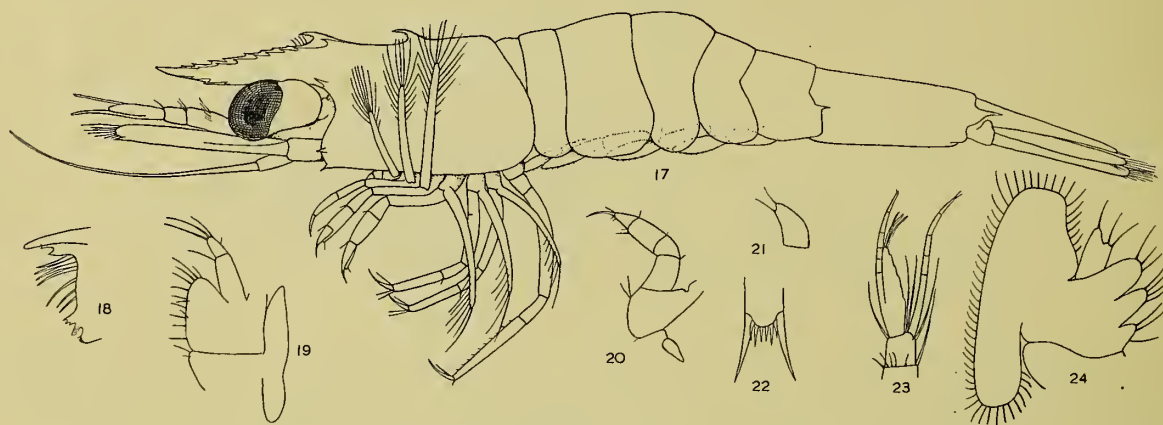
#### LOCALITY.

Great Barrier Reef. Stations 3, 44, 53.

#### DESCRIPTION.

Last stage. Length 9.85 mm.

Rostrum straight, rather deep, with large serrated spine at base and a series of very small dorsal, and one ventral teeth. Carapace with large serrated dorsal spine, small



TEXT-FIGS. 17-24.—Palaemonid B.R. I. (*Leander* sp. ?).

FIG. 17.—Last stage, lateral.

FIG. 18.—,, mandible.

FIG. 19.—,, maxillipede 1.

FIG. 20.—,, maxillipede 2.

FIG. 21.—Last stage, palp of maxillule.

FIG. 22.—,, end of telson.

FIG. 23.—,, end of antennule.

FIG. 24.—,, maxilla.

supraorbital, branchiostegal and pterygostomial spines. Abdomen straight, somite 5 with small lateral spines and rectangular pleura ; somite 6 with lateral spine. Anal spine absent. Telson five times as long as wide, without lateral spines, and with 4+4 terminal spines, the outer pair large.

Antennule, segment 1 with small ventral spine, but without outer distal spine ;

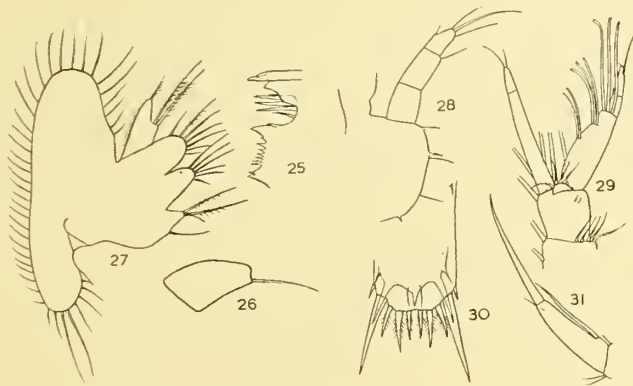
stylocerite small; otocyst cavity formed and surrounded by small setae, but not covered by extension of the stylocerite; exopod deeply cleft. Antennal scale with small distal spine; flagellum longer than scale.

Maxillule, endopod small, with two apical setae. Maxilla, exopod large, outer margin fringed with setae; endopod with basal lobe bearing two setae.

Maxillipede 1, coxa large, with large bilobed epipod; basis not protuberant, with numerous setae; endopod of two segments; exopod widened at base, with numerous setae, 6 apical setae. Maxillipede 2, coxa with small epipod; basis without spines; endopod of four segments, without strong spines. Maxillipede 3, dactyl with one strong terminal spine.

Exopods of maxillipedes with numerous setae.

Legs 1 and 2 chelate, leg 2 somewhat the larger. Legs 3 and 4 alike, leg 4 with exopod. Leg 5 not much larger than leg 4; propod with a series of small spines along inner margin, but without strong terminal spines; dactyl with basal spine.



TEXT-FIGS. 25-31.—*Leander* (last stage).

FIG. 25.—*L. serratus* mandible.

FIG. 26.—,, palp of maxillule.

FIG. 27.—,, maxilla.

FIG. 28.—*L. squilla elegans*, maxillipede 1.

FIG. 29.—*L. serratus* end of antennule.

FIG. 30.—,, end of telson.

FIG. 31.—,, leg 5, dactyl.

Pleopods large, with small points on outer side, and setae on inner side of exopods; appendix interna well developed.

#### REMARKS.

This larva differs so little from the corresponding stage in European species of *Leander* that I feel justified in referring it to that genus. I give some figures of the telson and appendages of the last larva of *Leander serratus* for comparison (Text-figs. 25-31), from which it will be seen that there are differences in telson and some appendages; but they are not great. It will be noted, however, that the exopod of the antennule in this form is very much farther advanced than it is in the last larval, or even the first post-larval stage of *L. serratus*. This early bifurcation of the outer flagellum will be seen also in some other larvae described below.

Some specimens which can be definitely referred to *Leander* of the *L. serratus* type were found in a sample from Barrier Reef Station 38.



*Brachycarpus biunguiculatus* (Lucas). (Text-figs. 32-38.)

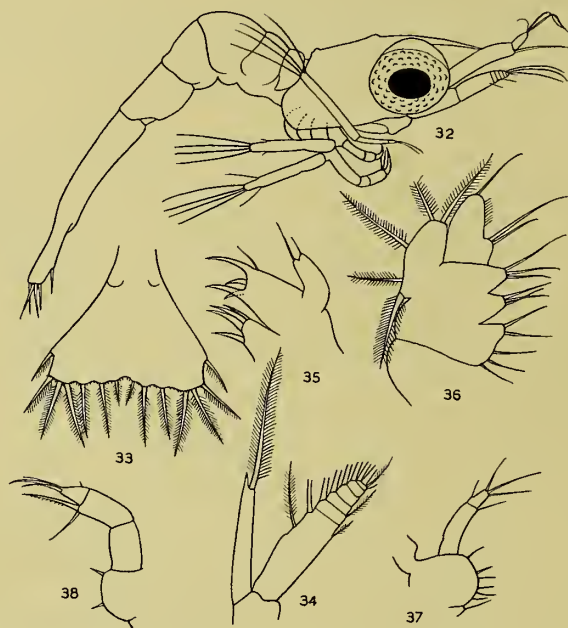
## LOCALITY.

I am indebted to Dr. J. F. G. Wheeler for larvae of this species hatched out at the Bermuda Biological Station.

## DESCRIPTION.

Stage I. Length 2.2 mm.

Carapace with small dorsal papilla and long slender rostrum reaching to about two-thirds length of antennular peduncle. There is a minute point representing the pterygostomial spine, but hidden by the eye in side view. Abdominal somites without dorsal



TEXT-FIGS. 32-38.—*Brachycarpus biunguiculatus* (Lucas).

FIG. 32.—Stage I, lateral.

FIG. 33.— „ telson.

FIG. 34.— „ antenna.

FIG. 35.— „ maxillule.

FIG. 36.—Stage I, maxilla.

FIG. 37.— „ maxillipede 1.

FIG. 38.— „ „ 2.

or lateral spines. Telson with nearly straight posterior margin; innermost spine very short.

Antennal scale slender, with five distal segments well marked; two outer and ten inner and terminal setae. There is a trace of the inner knob characteristic of Pontoniinae and some Alpheidae. Endopod a straight rod, with long seta and small inner apical spine.

Maxillule, endopod bilobed at end, with two small setae. Maxilla, endopod with basal lobe bearing two setae; proximal lacinia large, with five setae; exopod with five setae.

Maxillipede 1 coxa reduced; basis protuberant, with several small setae; endopod unsegmented, or faintly three segmented; exopod with five setae. Maxillipede 2, endopod

of three segments, with strong spines on segments 2 and 3 : basis with two small spines. Maxillipede 3, dactyl with one strong apical spine. Exopods of maxillipedes 2 and 3 with six setae.

Rudiments of legs 1 and 2 present.

#### REMARKS.

Although only Stage I was obtained, it is of some interest as this is the first species of the *Palaemon* group of which the free larva has been seen. As was to be expected, the larva at this stage cannot be distinguished generically from *Leander*. We have no indication as to what the later stages may be like, but it is quite possible that they may be included in one of the forms of *Retrocaris* described below.

#### *Retrocaris*.

This larval genus was founded by Ortmann (1893) for two species, *R. contraria* and *R. spinosa*. A third, *R. antarctica*, was described by Coutière (1907). Coutière referred these larvae to the Palaemonidae, but ventured the suggestion that *R. antarcticus* might be the larva of *Campylonotus vagans*, the adult of which species was taken at the same station. While Coutière's specimen was only 5 mm. long Ortmann's *R. contraria* was 16 mm., and Coutière regarded it as one of those "giant larvae" which he believed to be due to abnormal development. I have described myself (1924, p. 123) specimens resembling *R. contraria* of sizes between 9.5 and 19 mm., and have suggested that they may be larvae of *Palaemon*.

The "Discovery" collection contains 20 specimens from six stations, evidently belonging to two species. Of one of these I have also 15 specimens from "Atlantis" Station 1121.

#### Palaemonid D. I (*Palaemon* sp. ?) (Text-figs. 39-52.)

*Retrocaris spinosa*, Ortmann ?, 1893, p. 84.

*Palaemon* sp. ?, Gurney, 1924, p. 123.

#### LOCALITY.

"Atlantis" Station 1121. 37° 53' N., 62° 45' W.

#### DESCRIPTION.

Length 18 mm. Rostrum longer than scale, with six dorsal and three ventral teeth ; the basal dorsal tooth slightly larger than the rest and serrated ; end of rostrum serrated dorsally. Carapace with two large serrated dorsal teeth and a posterior papilla ; supra-orbital, hepatic and branchiostegal spines present, large. In one of the "Atlantis" specimens, of 17 mm., red lines are still visible on carapace and abdomen, and their position has been indicated in Text-fig. 39.

Abdominal pleura large, those of somites 1-4 with small procurved tooth ; somite 3 with very large procurved dorsal process strongly serrated along anterior margin ; somite 5 with large lateral spines and pleura rectangular, or with small spine at angle ; somite 6 one and a half times as long as deep, with large posterior lateral spines. Anal spine absent. Telson four times as long as wide, with two pairs of lateral spines and 5 + 5 terminal, of which the second pair is the largest.

Antennule with well-developed stylocerite and strong apical outer spine on segment 1 ; segment 1 with ventral spine ; outer flagellum deeply cleft. Antennal scale widest about

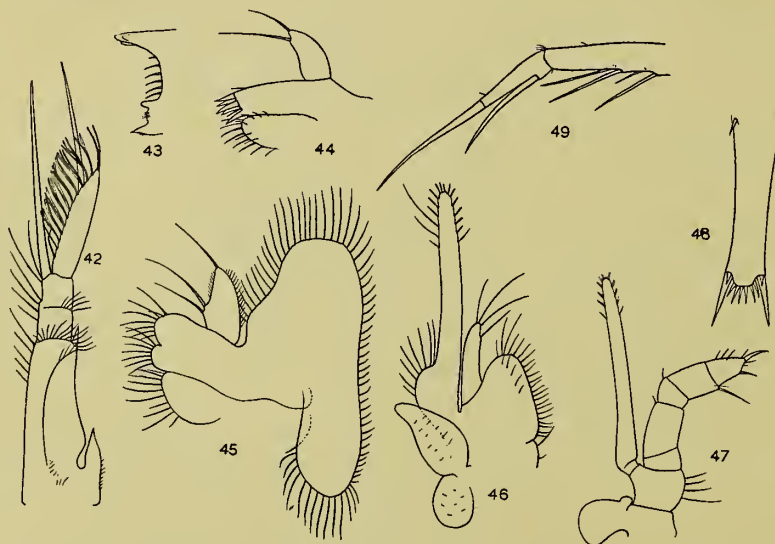
middle and more than three times as long as wide ; apical spine very large ; flagellum long, but broken. Mandible without palp, with six rather small spines between incisor and molar parts.

Maxillule, endopod unsegmented, with two setae ; lacinia 2 with five or six spines.



Maxilla, exopod very large, outer margin fringed with setae ; endopod with basal lobe bearing two setae.

Maxillipede 1 with large bilobed epipod ; exopod widened at base, with several setae at this point ; basis large, with straight inner margin ; endopod unsegmented. Maxilli-



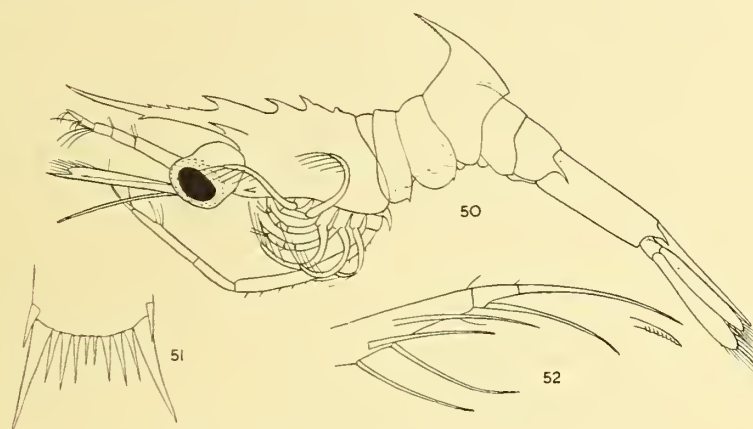
pede 2, basis with small setae ; epipod large, with small lobe representing podobranch ; endopod of five segments. Maxillipede 3 with two rudimentary gills. One of these gills is foliated and the other a simple papilla, but they are so close together that it is impossible to designate one of them as a pleurobranch ; both, by position, are arthrobranchs.



Legs 1 and 2 chelate, leg 2 slightly the larger. Legs 3 and 4 alike, with exopods, the dactyl with small terminal spine and propod without long terminal spines. Leg 5 reaching forward to end of antennal scale. Coxa with large curved spine; propod with a group of long straight spines, serrated at the end; dactyl with large spine at base and long terminal spine serrated at end.

Lengths of segments: Dactyl and spine, 1.2 mm.; propod, 2.38 mm.; carpus, 1.46 mm.; ischiomere, 4.0 mm.

Pleopods large, with setae.



TEXT-FIGS. 39-52.—*Retrocaris* (*Palaemon*).

FIG. 39.—Palaemonid D. I. 11 mm. "Discovery" Station 709. Heavy lines on carapace and abdomen indicate red markings.

FIG. 40.— " telson.

FIG. 41.— " legs 1 and 2.

FIG. 42.—Palaemonid D. I. 18 mm. "Atlantis" Station 1121. Antennule.

FIG. 43.— " mandible.

FIG. 44.— " maxillule.

FIG. 45.— " maxilla.

FIG. 46.— " maxillipede 1.

FIG. 47.— " " 2.

FIG. 48.— " telson.

FIG. 49.— " leg 5.

FIG. 50.—Palaemonid D. I. 7.6 mm. "Discovery" Station 708.

FIG. 51.— " part of telson.

FIG. 52.— " part of leg 5.

#### REMARKS.

This description is taken from one of the largest specimens. The smallest measures 7.6 mm. and differs in having fewer and smaller teeth on the rostrum (Text-fig. 50); the basal tooth, which really belongs to the carapace series, is strikingly larger than those on the rostrum itself. The telson has an additional pair of terminal spines; legs 1 and 2 are not chelate; the pleopods are traceable only as small papillae; the flagella of the antennule are quite small, the outer one not cleft.

This is, no doubt, the same species as I have described from "Terra Nova" Stations 46 and 49, but in that case the endopod of maxillipede 1 was found to be segmented, and I must assume an error in the shape of the pleura of somite 5 shown in the figure. In these large, opaque specimens such an error is easily made.

Janeiro. It was, however, also taken on the eastern side of the ocean near the Cape Verde Islands, and so wide a distribution suggests that there may be two species included.

#### DISTRIBUTION OF *Retrocaris* LARVAE.

				Number of specimens.	
				D. I.	D. II.
"Discovery"					
Station 691	.	.	00° 25' S., 29° 56' W.	1	..
„ 701	.	.	14° 39' N., 25° 51' W.	1	..
„ 704	.	.	3° 37' N., 29° 14' W.	..	2
„ 706	.	.	3° 26' N., 32° 08' W.	..	6
„ 708	.	.	10° 26' S., 34° 54' W.	1	..
„ 709	.	.	14° 01' S., 36° 30' W.	4	..
„ 711	.	.	24° 40' S., 41° 30' W.	5	..
"Atlantis"					
Station 1121	.	.	37° 53' N., 62° 45' W.	15	..
"Terra Nova"					
Station 46	.	.	20° 30' S., 36° 30' W.}	6	..
„ 49	.	.	18° 51' S., 33° 40' W.}		

I have attached the name *Palaemon* to both the species; but it is probable that one of them may be, or includes, *Brachycarpus unguiculatus*.

Coutière's suggestion that *Retrocaris* may be the larva of *Campylonotus* can be dismissed, since the gill formula of the oldest specimens is evidently complete, and there is no trace of epipods or arthrobranchs on any of the legs.

#### DISCUSSION OF THE LARVAE OF PALAEMONINAE.

Having regard to the fact that we know fully the larvae of all the European species of Palaemoninae, and that they agree in almost every detail, one would suppose that the generic characters would be as securely founded as could well be. Nevertheless Yokoya's description of *L. paucidens* (De Haan) shows that there may be important differences, since in this species leg 5 becomes very much larger than in the other species, and indeed approaches the disproportionate size seen in *Retrocaris*. In *L. tenuicornis*, while the general form in Stages I and II is exactly the same as in the European species, the structure of the maxilla and maxillipedes is very different, and approaches very closely to that found in some Pontoniinae. It is unfortunate that later larvae in which legs 4 and 5 are developed are not known, but the differences in the maxillipedes are so great that one is tempted to suggest that *L. tenuicornis* should be excluded from *Leander*. The adult has in fact certain exceptional characters, as has been pointed out by Kemp (1925, p. 302). The colouring is very unusual, and the pigmentation of the eye is such as is "not often seen in *Leander*". The cornea is marked with bands of dark pigment, and such bands "are of very frequent occurrence in *Periclimenes* and other genera of Pontoniinae". The sexual difference in length of leg 2 is also a most unusual feature according to Kemp; and the endopod of pleopod 1 in the male has an appendix interna. So far as is known this appendix is found among Palaemonidae only in *Urocaridella gracilis*, *Palaemonetes*

*hornelli* and *Anchistioides antiguensis*.\* In my own specimens the palp of the mandible has two segments only, as in *L. squilla*, *L. cubensis* and *L. semmelinki*.

When one considers that the genus *Palaemonetes* is generally accepted as distinct from *Leander* although it differs only in the absence of the mandible palp and of the pleurobranch on maxillipede 3 it is not unreasonable to claim that the peculiarities of the larva combined with those of the adult would justify the same separation of *L. tenuicornis*.

#### SUMMARY OF THE CHARACTERS OF THE LAST LARVA.

##### *Leander*. (Excluding *L. tenuicornis* (Say).)

Carapace with one or more dorsal spines; pterygostomial and branchiostegal spines present, antennal and hepatic absent. Abdominal somite 3 without dorsal spine; somite 5 with lateral spines, except in *L. paucidens*; anal spine present or absent. Telson with two pairs of very small lateral spines, or without them; apical spines usually 5 + 5, spine 2 large, but spine 1 very small and sometimes absent.

Antennule with ventral spine. Antennal scale with spine.

Maxillule, endopod bilobed at end, with one seta.

Maxilla, endopod with basal lobe; exopod with setae along outer margin.

Maxillipede 1, basis small, not protuberant, without spines. Maxillipede 2, basis not protuberant, without spines. Maxillipede 3, dactyl with one strong terminal spine.

Leg 4 with exopod (except in *L. longirostris*); developing later than leg 5; structure as leg 3.

Leg 5 larger than leg 4, but usually not much larger; dactyl with basal spine.

##### *Retrocaris* (*Palaemon* or *Brachycarpus*).

As above, but differing as follows:

Abdominal somite 3 with dorsal spine. Anal spine absent.

Telson with 5 + 5 or 6 + 6 apical spines, very slender.

Maxillipede 3 basis large, somewhat produced distally.

Leg 5 very long, twice as long as leg 4.

#### 1B. PONTONIINAE.

The first larva of the following species was obtained by hatching in the laboratory at Ghardaqa: †

*Periclimenes* (*Ancylocaris*) *grandis* (Stimpson).

*P. (A.) agag*, Kemp.

*P. (A.) diversipes*, Kemp.

*Harpilius beaupresi* (Audouin).

*H. gerlachei*, Nobili.

*Coralliocaris graminea* (Dana).

\* According to Schmitt (1935, p. 61) it is present in *Leander paulensis* (Ortmann), which is probably a synonym of *L. tenuicornis*. It is also found in the male of *Gnathophyllum fasciolatum*; in some *Atyidae* and in *Rhynchocinetes* (Gordon, 1935).

† For the identification of these and other species from the Red Sea I am much indebted to Dr. M. Ramadan.



*Conchodytes biunguiculatus* (Paulson) was seen, but the eggs were in quite early stages, while *Palaemonella tenuipes* (Dana) and *Periclimenes petittouarsi* (Audouin) had not begun to breed. It is unfortunate that the species of *Periclimenes* belong to the subgenus of which the larvae are already known, and that late stages of *Harpilius* and *Coralliocaris* could not be identified. Pontoniid larvae were rare in the plankton at that time, but four types are described below.

The Barrier Reef plankton contains large numbers of Pontoniid larvae in late stages, among which those of *Periclimenes* predominate. I have made no attempt to examine the whole of this material in detail; but I have selected for description those forms which show striking characters, or may be supposed to represent types rather than species. The variety in form and structure of appendages is astonishing and baffling.

#### GROUP I: *Periclimenes*.

*Periclimenes grandis* (Stimpson). (Text-figs. 54-60.)

##### LOCALITY.

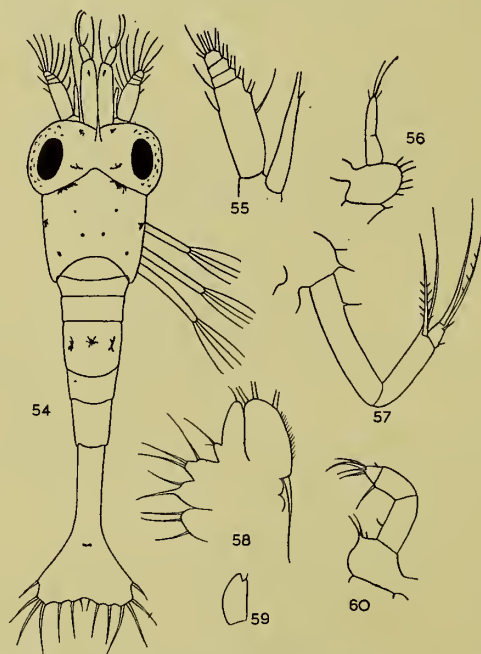
Common, together with *P. agag*, Kemp, on *Halophila* near the laboratory at Ghardaqa.

##### DESCRIPTION.

Stage I. Length 1.63-1.8 mm.

Rostrum very small and slender. Abdomen straight; pleura rounded. Telson with posterior margin nearly straight, spine 4 not much longer than 3, and innermost pair very small.

Antennal scale with three distinct segments; two outer and ten inner and terminal setae; proximal papilla absent; endopod with long seta and very small terminal spine.



TEXT-FIGS. 54-60.—*Periclimenes grandis* (Stimpson).

FIG. 54.—Stage I, dorsal.

FIG. 55.—,, antenna.

FIG. 56.—,, maxillipede 1.

FIG. 57.—,, maxillipede 2.

FIG. 58.—Stage I, maxilla.

FIG. 59.—,, palp of maxillule.

FIG. 60.—,, maxillipede 2.

Endopod of maxillule small, broad, bilobed at end, with one small seta. Endopod of maxilla with very small terminal seta and small basal lobe; exopod with four setae only.

Maxillipede 1, endopod not distinctly segmented; basis protuberant; exopod with four setae. Maxillipede 2, basis with two small spines; endopod of three segments. Maxillipede 3, endopod very long and slender, apparently of three segments only; dactyl with two long subequal terminal spines, as in *Leander tunnicornis*. In *P. americanus* Stage I, as in *P. grandis*, there are two long apical spines only. In Stage II two small spines appear at the end of the dactyl, and in later stages the long accessory spine is replaced by a very small one, so that the dactyl then bears only one strong apical spine, with three small spines at its base.

Exopods of all maxillipedes with four setae. Rudiments of legs 1 and 2 present.

Colour: General colour olive; with some red and yellow chromatophores. No ventral chromatophores in abdomen.

#### REMARKS.

The first larva of *P. agag* cannot be distinguished from that of *P. grandis*, as described above. Colour differences, if any, were not noted.

### *Periclimenes diversipes*, Kemp. (Text-figs. 61–66.)

#### LOCALITY.

A very small, colourless species found among living corals at Ghardaqa.

#### DESCRIPTION.

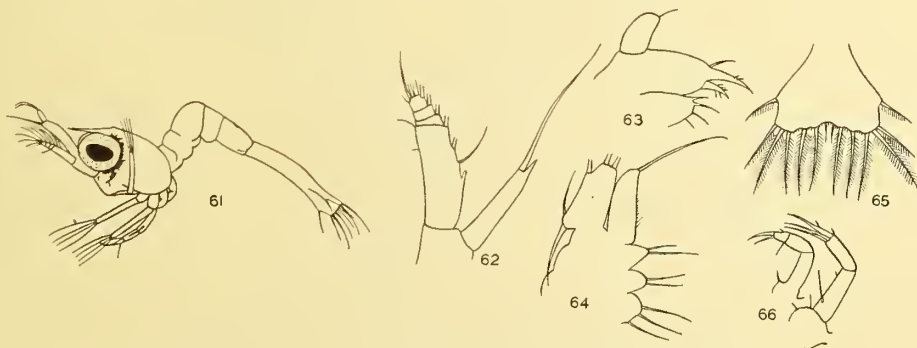
Stage I. Length 1.6 mm.

Rostrum long and slender. Abdomen very much bent at somite 3; pleura rounded. Telson as in *P. grandis*, innermost pair of spines very small.

Antenna, exopod with three distal segments; two outer setae, of which the proximal one is very small; inner papilla well marked; endopod with long seta and large spine.

Endopod of maxillule not bilobed, with one small seta. Maxilla, endopod with long apical seta and without basal lobe; exopod with five setae.

Maxillipede 1, endopod unsegmented; basis slightly protuberant, with three setae only. Maxillipede 3, dactyl with a single strong terminal spine. Rudiments of legs 1 and 2 present.



TEXT-FIGS. 61–66.—*Periclimenes diversipes*, Kemp.

FIG. 61.—Stage I, lateral.

FIG. 62.— „ antenna.

FIG. 63.— „ maxillule.

FIG. 64.—Stage I, maxilla.

FIG. 65.— „ telson.

FIG. 66.— „ maxillipedes 2 and 3.

Colour : Abdomen and posterior part of thorax colourless ; very large chromatophore behind eye with red centre but appearing yellow in reflected light.

REMARKS.

While *P. calmani*, *P. americanus* and *P. grandis* agree in almost every detail, so that it would be difficult to distinguish them, *P. diversipes* differs so much from all of them that one would suppose it should be referred to a distinct genus or subgenus. Such differences are the very well-developed antennal papilla ; form of endopod of maxillule ; presence of five setae on exopod, and absence of basal lobe on endopod of maxilla ; and terminal spines of maxillipede 3.

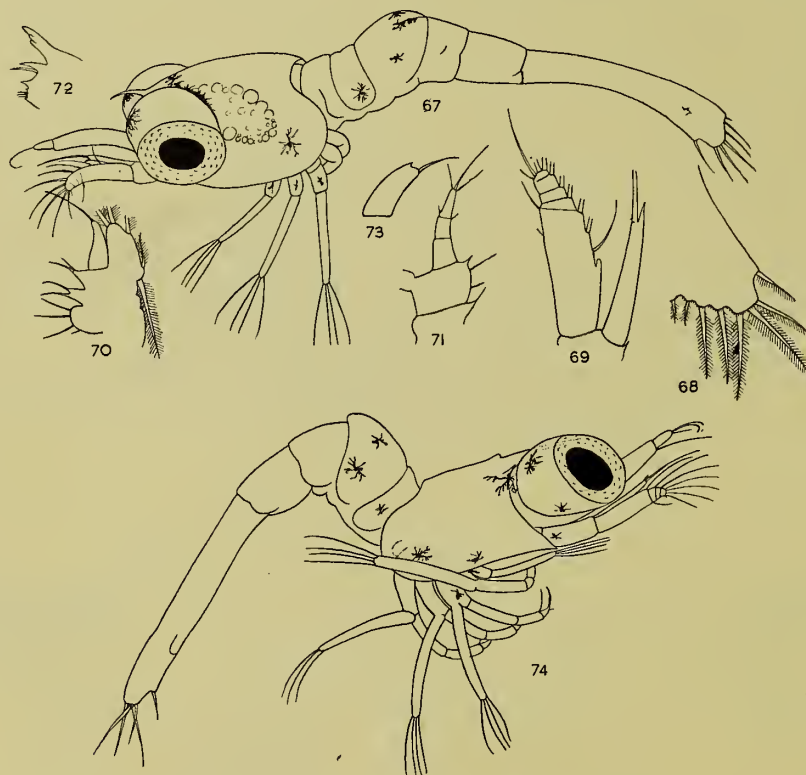
*Harpilius beaupresi* (Audouin). (Text-figs. 67-74.)

DESCRIPTION.

Stage I. Length 2.15 mm.

Rostrum slender, extending beyond eye. Carapace broad. Abdomen slightly bent and rather broad, somite 3 rather swollen ; pleura rounded. Telson broad, rather deeply indented, the innermost spines short, and spine 4 slightly the longest.

Antenna, exopod with four distinct segments ; two outer setae, of which the proximal is minute ; inner margin with well-developed papilla ; endopod with long apical seta and large spine. Mandible large, with large spine between molar and trifold incisor part.



TEXT-FIGS. 67-74.—*Harpilius beaupresi* (Audouin).

FIG. 67.—Stage I, lateral.

FIG. 68.— „ telson.

FIG. 69.— „ antenna.

FIG. 70.— „ maxilla.

FIG. 71.—Stage I, maxillipede 1.

FIG. 72.— „ mandible.

FIG. 73.— „ maxillule, palp.

FIG. 74.—Stage II, lateral.



Maxillule, endopod slightly bilobed at end, with one seta. Maxilla, endopod with apical seta but no basal lobe or seta; exopod with five setae.

Maxillipede 1, endopod indistinctly three-segmented; basis with spine and two setae, not protuberant. Maxillipedes 2 and 3 with similar dactyls bearing one strong terminal spine. Exopods with four setae.

Rudiments of legs 1 and 2 present.

Colour: Thorax yellowish, abdomen very faintly coloured. Chromatophores behind eye with olive and red pigment and faint yellow branches, the red largely hidden by the olive.

#### Stage II.

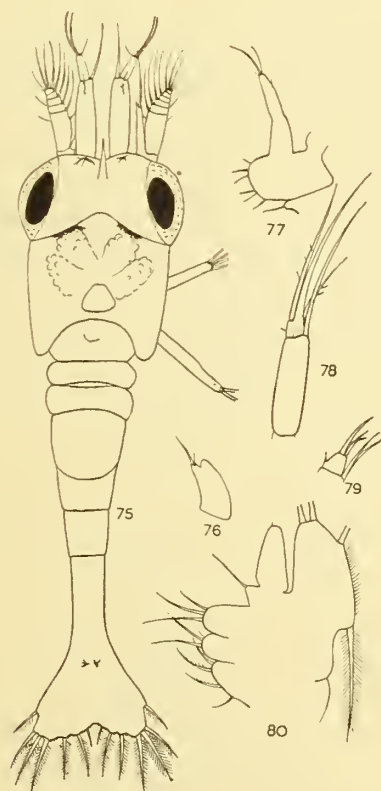
A few specimens moulted in the laboratory without increase in size.

Carapace with anterior papilla, but no dorsal spine; supra-orbital spine small; anterior angle pointed.

Abdomen sharply bent at somite 3; pleura rounded. Telson unchanged except for presence of additional small inner pair of spines.

Antenna unchanged, except for appearance of a very small seta at base of terminal spine of endopod.

Legs 1 and 2 developed, with exopods bearing four setae. Leg 3 a small rudiment.



TEXT-FIGS. 75-80.—*Harpilius gerlachei*, Nobili.

FIG. 75.—Stage I, dorsal.

FIG. 76.—,, maxillule, palp.

FIG. 77.—,, maxillipede 1.

FIG. 78.—Stage I, maxillipede 3.

FIG. 79.—,, ,, 2.

FIG. 80.—,, maxilla.

Colour : Abdomen and posterior part of thorax colourless ; very large chromatophore behind eye with red centre but appearing yellow in reflected light.

REMARKS.

While *P. calmani*, *P. americanus* and *P. grandis* agree in almost every detail, so that it would be difficult to distinguish them, *P. diversipes* differs so much from all of them that one would suppose it should be referred to a distinct genus or subgenus. Such differences are the very well-developed antennal papilla ; form of endopod of maxillule ; presence of five setae on exopod, and absence of basal lobe on endopod of maxilla ; and terminal spines of maxillipede 3.

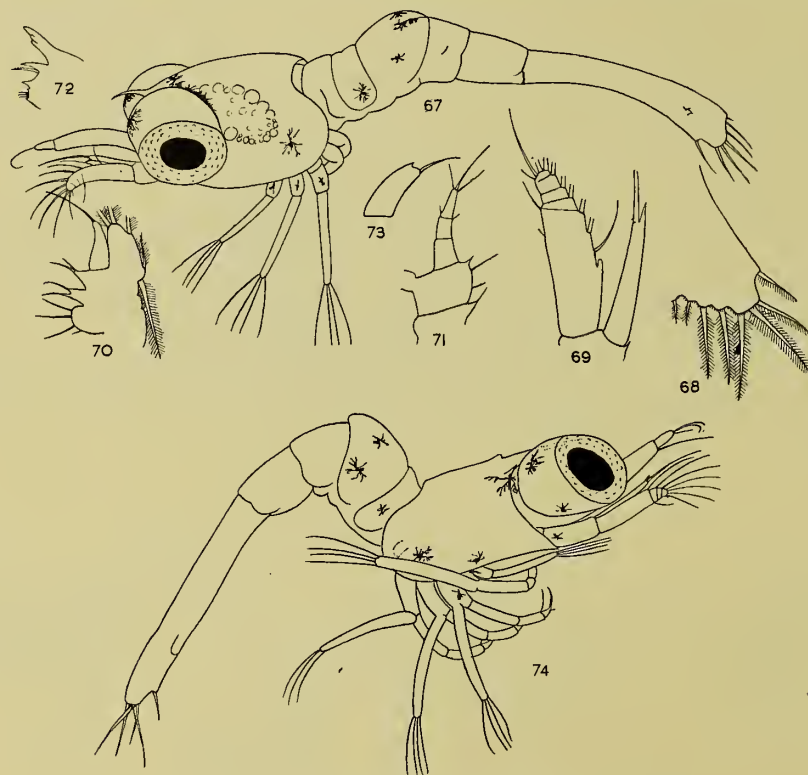
*Harpilius beaupresi* (Audouin). (Text-figs. 67-74.)

DESCRIPTION.

Stage I. Length 2.15 mm.

Rostrum slender, extending beyond eye. Carapace broad. Abdomen slightly bent and rather broad, somite 3 rather swollen ; pleura rounded. Telson broad, rather deeply indented, the innermost spines short, and spine 4 slightly the longest.

Antenna, exopod with four distinct segments ; two outer setae, of which the proximal is minute ; inner margin with well-developed papilla ; endopod with long apical seta and large spine. Mandible large, with large spine between molar and trifold incisor part.



TEXT-FIGS. 67-74.—*Harpilius beaupresi* (Audouin).

FIG. 67.—Stage I, lateral.

FIG. 68.— „ telson.

FIG. 69.— „ antenna.

FIG. 70.— „ maxilla,

FIG. 71.—Stage I, maxillipede 1.

FIG. 72.— „ mandible.

FIG. 73.— „ maxillule, palp.

FIG. 74.—Stage II, lateral.

Maxillule, endopod slightly bilobed at end, with one seta. Maxilla, endopod with apical seta but no basal lobe or seta; exopod with five setae.

Maxillipede 1, endopod indistinctly three-segmented; basis with spine and two setae, not protuberant. Maxillipedes 2 and 3 with similar dactyls bearing one strong terminal spine. Exopods with four setae.

Rudiments of legs 1 and 2 present.

Colour: Thorax yellowish, abdomen very faintly coloured. Chromatophores behind eye with olive and red pigment and faint yellow branches, the red largely hidden by the olive.

## Stage II.

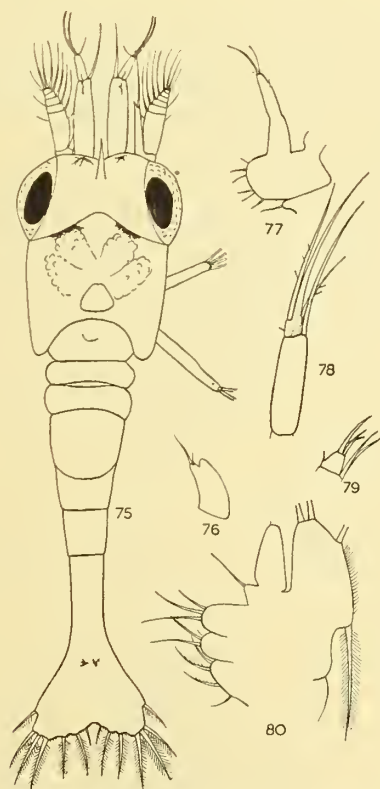
A few specimens moulted in the laboratory without increase in size.

Carapace with anterior papilla, but no dorsal spine; supra-orbital spine small; anterior angle pointed.

Abdomen sharply bent at somite 3; pleura rounded. Telson unchanged except for presence of additional small inner pair of spines.

Antenna unchanged, except for appearance of a very small seta at base of terminal spine of endopod.

Legs 1 and 2 developed, with exopods bearing four setae. Leg 3 a small rudiment.



TEXT-FIGS. 75-80.—*Harpilius gerlachei*, Nobili.

FIG. 75.—Stage I, dorsal.

FIG. 76.—,, maxillule, palp.

FIG. 77.—,, maxillipede 1.

FIG. 78.—Stage I, maxillipede 3.

FIG. 79.—,, ,, 2.

FIG. 80.—,, maxilla.



*Harpilius gerlachei*, Nobili. (Text-figs. 75-80.)

## DESCRIPTION.

Stage I. Length 2 mm.

General form as in *H. beaupresi* but differing from it in structure of appendages as follows :

Endopod of maxillule with additional small seta. Maxilla, endopod with minute apical seta and well-marked basal lobe ; exopod with four setae only.

Maxillipede 1, basis very protuberant, without spines. Maxillipede 3, dactyl bearing a pair of long subequal spines.

Colour : Almost colourless. Dark red behind eye, and orange in stomach region. No chromatophores seen in abdomen, but a small pair in telson.

## REMARKS.

While this species agrees with typical *Periclimenes* in form of maxilla and maxillipedes 1 and 3 so closely that it could not be separated generically, *H. beaupresi* differs in exactly the same way from *H. gerlachei* as *P. diversipes* differs from the other species of *Periclimenes*.

*Coralliocaris graminea* (Dana). (Text-figs. 81-89.)

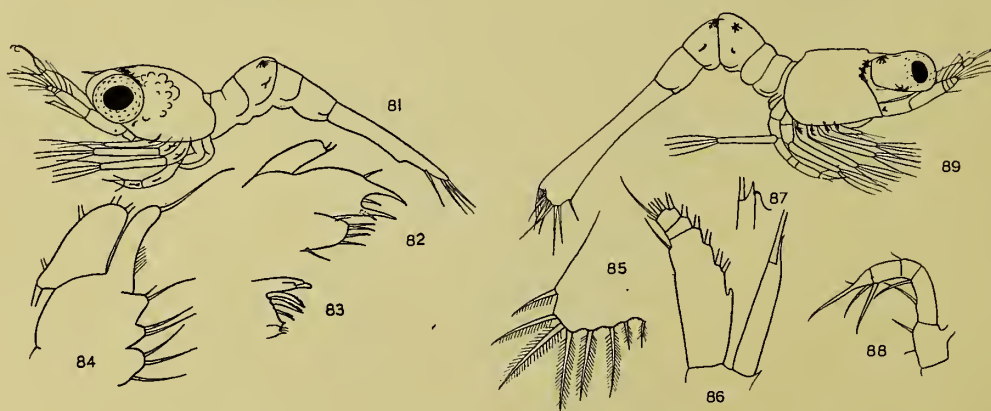
## LOCALITY.

Common among the branches of *Stylophora* at Ghardaqa.

The animal snaps its large claws in exactly the same way as an Alpheid does. The eggs are borne on legs 1-3, in which the coxa is greatly elongated. Leg 1 seems to carry the most eggs, but in each leg there are only two groups of ovigerous setae, two setae at the distal and three at the proximal end of the basis.

Stage I. Length 2.2 mm.

Body slightly bent at junction of thorax and abdomen, and at abdominal segment 3. Rostrum slender, extending beyond eye. Abdominal pleura rounded. Telson broad, slightly indented, the innermost pair of spines short ; spine 4 as long as spine 2.



TEXT-FIGS. 81-89.—*Coralliocaris graminea* (Dana).

FIG. 81.—Stage I, lateral.

FIG. 82.— „ maxillule.

FIG. 83.— „ mandible

FIG. 84.— „ maxilla.

FIG. 85.— „ telson

FIG. 86.—Stage I, antenna.

FIG. 87.— „ antenna, Stage II, tip of endopod.

FIG. 88.— „ maxillipede 2.

FIG. 89.—Stage II, lateral.

Antennal scale with three segments distinct; proximal outer seta reduced to a minute hair; endopod with long seta and large spine. Inner marginal papilla well developed. Maxillule, endopod with two very small setae. Maxilla, endopod slender, with long apical seta but no basal lobe or seta; exopod with five setae.

Maxillipede 1, basis not protuberant, with one spine and a seta; endopod unsegmented, or faintly three-segmented; exopod with four setae. Maxillipede 2, basis with one small spine. Maxillipede 3, dactyl with one strong terminal spine; exopod with four setae. Large rudiments of legs 1 and 2.

General colour brick-red.

#### Stage II.

A few specimens moulted to Stage II, but without increase in length.

Carapace without supraorbital spine. Abdomen slightly bent; pleura rounded.

Antenna unchanged, but endopod with small seta at base of terminal spine as in *Harpilius beaupresi*.

Legs 1 and 2 developed; dactyl with strong apical spine. Small rudiments of legs 3 and 4.

#### REMARKS.

Except in colour, and absence of supra-orbital spine in Stage II, this larva is almost identical with that of *Harpilius beaupresi*; indeed the latter resembles *C. graminea* very much more than that of *H. gerlachei*.

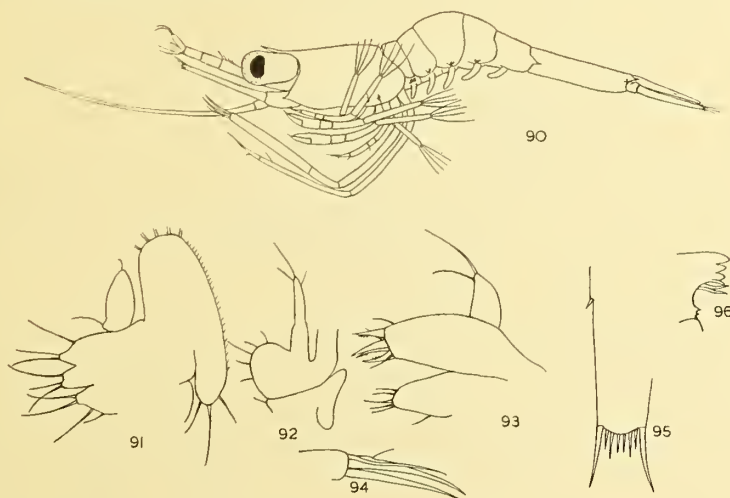
#### Palaemonid R.S. I (*Periclimenes*). (Text-figs. 90-96.)

#### LOCALITY.

Ghardaqa, plankton.

#### DESCRIPTION.

Stage V? Length 5.0 mm.



TEXT-FIGS. 90-96.—Palaemonid R.S. I. (*Periclimenes*.)

FIG. 90.—Stage V?, lateral.

FIG. 91.—,, maxilla.

FIG. 92.—,, maxillipede 3.

FIG. 93.—,, maxillule.

FIG. 94.—Stage V?, dactyl of leg 4.

FIG. 95.—,, telson.

FIG. 96.—,, mandible.

Rostrum shorter than eye, without teeth; carapace without supra-orbital spines but with pterygostomial angle pointed. Abdomen nearly straight, somites 5 and 6 with lateral spines. Telson with one pair of lateral spines and 4 + 4 distal, the outer pair large. Anal spine absent.

Antennule with rudiment of stylocerite, without ventral spine on segment 1; outer flagellum unsegmented and not cleft. Antenna, scale narrow,  $4\frac{1}{2}$  times as long as wide; flagellum more than half length of body.

Maxillule, endopod not bilobed, with two apical setae. Maxilla, endopod with minute apical seta and small basal lobe; exopod fringed with hairs, but without setae on outer margin.

Maxillipede 1, basis protuberant, without spines; endopod not distinctly segmented. Maxillipedes 2 and 3, dactyl with one large apical spine. Exopods with four setae only.

Legs 1 and 2 chelate, nearly equal. Leg 4 longer and stouter than leg 5, without exopod; propod with long apical spines. Leg 5 long and slender, dactyl continuous with apical spine and without basal spine.

Pleopods small, without setae.

Colour: Almost colourless; end of antennal flagellum yellow.

Palaemonid B.R. II (*Periclimenes*). (Text-figs. 97-101.)

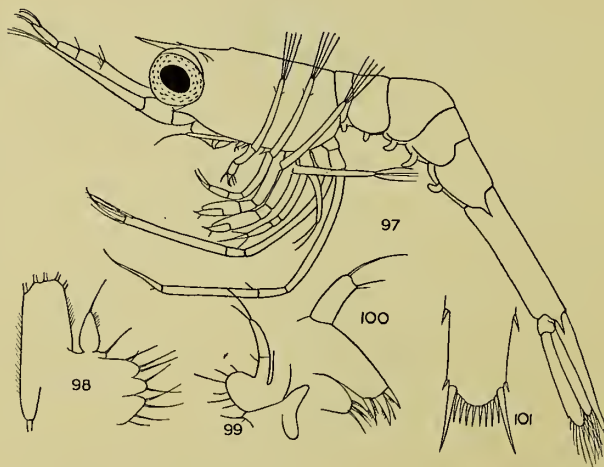
LOCALITY.

Barrier Reef Station 38.

DESCRIPTION.

Stage V? Length 4.0 mm.

Rostrum short, broadening at base, with median ridge and one small dorsal spine; carapace with supra-orbital and pterygostomial spines, but no antennal. Abdomen nearly straight, somites 5 and 6 with lateral spines. Telson four times as long as wide, with two pairs of lateral spines and 6 + 6 terminal, of which spine 2 is the largest. Anal spine absent.



TEXT-FIGS. 97-101.—Palaemonid B.R. II. (*Periclimenes*.)

FIG. 97.—Stage V?, lateral.

FIG. 98.—,, maxilla.

FIG. 99.—,, maxillipede 1.

FIG. 100.—Stage V?, maxillule.

FIG. 101.—,, part of telson.



Antennule, stylocerite small, no ventral spine on segment 1. Antennal scale four times as long as wide, with small apical spine.

Maxillule, endopod slightly bilobed, with three setae. Maxilla, palp with terminal seta and well-defined basal lobe; exopod very narrow proximally, where it bears one large seta only; outer margin without setae.

Maxillipede 1, basis protuberant, without spines; endopod two-segmented; exopod with four setae. Maxillipede 3, dactyl with one strong terminal spine; exopod with six setae, the proximal pair very small.

Legs 1 and 2 chelate, nearly equal, dactyl equal to, or shorter than, palm. Leg 4 without exopod, very elongated, and slightly longer than leg 5; propod with strong terminal spines. Leg 5 long and slender, without propodal spines, the terminal claw without a basal spine.

Pleopods small, without setae.

Palaemonid B.R. III (*Periclimenes*?). (Text-figs. 102–106.)

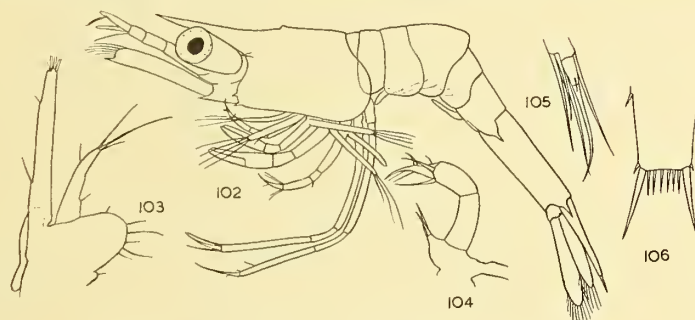
#### LOCALITY.

Barrier Reef Station 62.

#### DESCRIPTION.

Stage V? Length 5.35 mm.

Rostrum long and straight, without teeth; carapace with small supraorbital, branchiostegal and pterygostomial spines. Abdominal somite 3 rather protuberant; somites



TEXT-FIGS. 102–106.—Palaemonid B.R. III.

FIG. 102.—Stage VI?

FIG. 103.—,, maxillipede 1.

FIG. 104.—,, ,, 2.

FIG. 105.—Stage VI?, leg 4.

FIG. 106.—,, telson.

5 and 6 with lateral spines. Anal spine absent. Telson nearly four times as long as wide, with two pairs of lateral and 5 + 5 apical spines, spine 2 the largest.

Antennule with small stylocerite; exopod with very small slender extension beyond the thickened sensory basal part. Mandible with three large movable spines. Maxillule, endopod narrow, with two distal setae. Maxilla, endopod with small distal seta and basal lobe; exopod large with several setae at proximal end, but none on outer margin.

Maxillipede 1, basis very protuberant, without spines; endopod unsegmented; exopod with outer basal seta and with four apical. Maxillipede 2, basis protuberant, with two large spines; endopod of three segments; epipod absent. Maxillipede 3, dactyl with one strong apical spine.

Leg 4 as long as leg 5, without exopod; propod with long terminal spines. Leg 5 long and slender; apical claw without basal spine. Pleopods rather large, without setae.

Palaemonid D. III (*Periclimenes*?). (Text-figs. 107-112.)

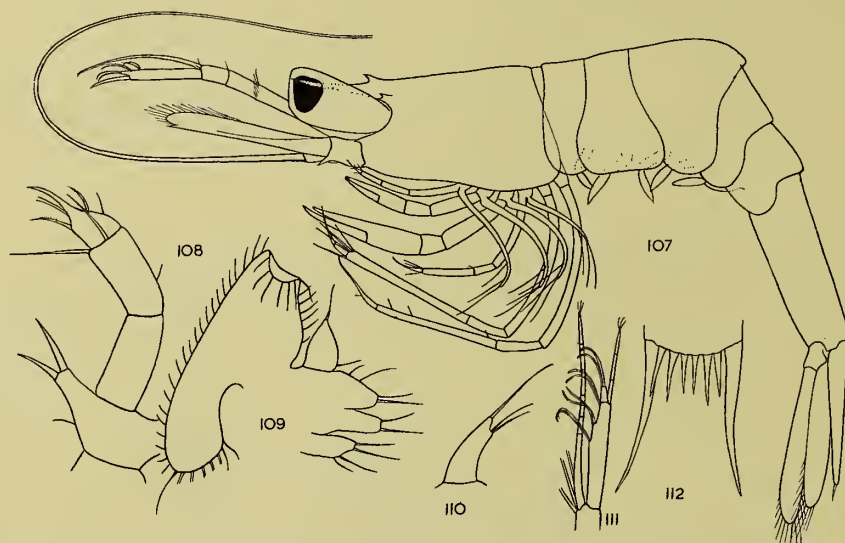
LOCALITY.

"Discovery" Station 701. 14° 39' N., 25° 51' W.

DESCRIPTION.

Length 8.2 mm.

Rostrum slender, as long as eye, with one dorsal tooth at base. Carapace with small supra-orbital, antennal and pterygostomial spines. Abdominal somite 3 rather protuberant; pleura of all somites rounded. Anal spine absent. Telson four times as



TEXT-FIGS. 107-112.—Palaemonid D. III.

FIG. 107.—Stage VI ?

FIG. 108.—,, maxillipede 2.

FIG. 109.—,, maxilla.

FIG. 110.—Stage VI ?, maxillule, palp.

FIG. 111.—,, antennule, end.

FIG. 112.—,, part of telson.

long as wide, with one pair of small lateral spines near middle, and 4 + 4 apical, the outer pair very large.

Antennule with small stylocerite but no ventral spine; exopod slightly cleft. Antennal scale with small distal spine; flagellum very long.

Maxillule, endopod with apical and two subapical setae. Maxilla, endopod small, with seta in place of basal lobe; exopod very large, with small setae on outer margin.

Maxillipede 1, endopod short and stout, of two distinct segments; basis very protuberant, without spines. Maxillipede 2, basis protuberant, with two very large spines; endopod stout, of three segments. Maxillipede 3, dactyl with single strong terminal spine.

Legs 1 and 2 chelate, leg 2 much the larger. Leg 4 slightly longer than leg 5, without exopod; propod with long terminal spines. Leg 5 slender; dactyl without basal spine.

Pleopods fairly large, without setae.

This species very closely resembles species B.R. III, in form of abdominal somite 3, maxillipede 2, etc., and no doubt belongs to the same genus.

Palaemonid D. IV (*Periclimenes* ?). (Text-figs. 113–118.)

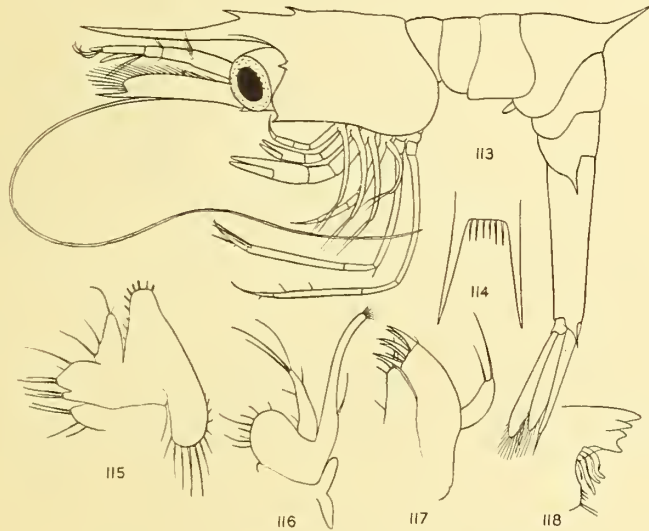
## LOCALITY.

“Discovery” Station 1374. 31° 46' S., 29° 46' E.

## DESCRIPTION.

Length 10.34 mm.

Rostrum longer than antennule, with one large dorsal tooth; carapace with dorsal, supra-orbital and pterygostomial spines. Abdominal somite 3 with large straight dorsal spine; somites 5 and 6 with lateral spines; anal spine absent. Telson four times as long as wide, with one pair of lateral spines and 4 + 4 distal. The outermost spines are very large and fused with the telson, forming a fork within which are six small spines.



TEXT-FIGS. 113–118.—Palaemonid D. IV.

FIG. 113.—Stage VI ?

FIG. 114.—,, telson.

FIG. 115.—,, maxilla.

FIG. 116.—Stage VI ?, maxillipede 1.

FIG. 117.—,, maxillule.

FIG. 118.—,, mandible.

Antennule with stylocerite, but no ventral spine; exopod not cleft, but with two small distal segments distinct. Antenna, basis with stout spine; scale with very large terminal spine; flagellum very long.

Mandible with four movable spines. Maxillule, endopod slender, curved, with two apical setae. Maxilla, endopod with trace of basal lobe and two setae on inner margin; exopod large, without setae on most of the outer margin.

Maxillipede 1, basis protuberant without spines; endopod unsegmented; exopod with outer basal seta and four apical. Maxillipede 2, basis with two very strong spines. Maxillipede 3, dactyl with single large apical spine.

Legs 1 and 2 chelate, leg 2 very much larger than leg 1. Leg 4 as long as leg 5, slender, without exopod; with long spines at end of propod. Leg 5 long and slender, the terminal claw without basal spine.

Pleopods small.



## Palaemonid B.R. IV. (Text-figs. 119-122.)

## LOCALITY.

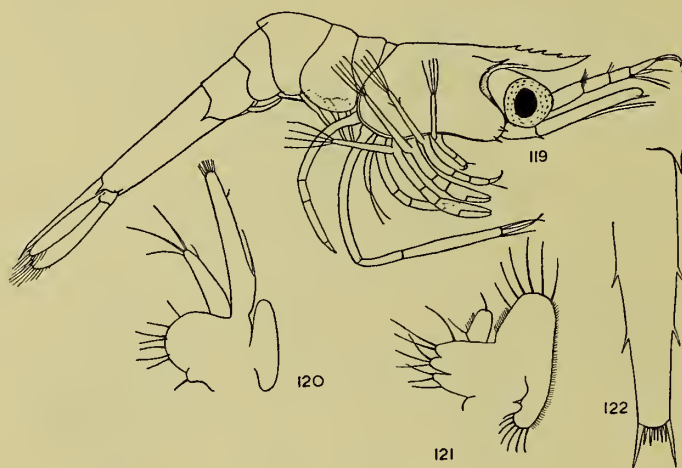
Barrier Reef Stations 16, 43, 50 and 53.

## DESCRIPTION.

Length 6 mm.

Rostrum rather deep, reaching beyond eyes, with five small dorsal teeth. In a specimen about to moult to post-larval there are four above and one below under the skin. Carapace with supra-orbital, branchiostegal and pterygostomial spines. Abdominal somites 5 and 6 with lateral spines. Anal spine absent. Telson more than four times as long as wide, with two pairs of lateral spines and 4 + 4 apical, the outer pair very large.

Antennule with small stylocerite and no ventral spine. Antennal scale with large spine; flagellum much longer than scale; basis with small spine.



TEXT-FIGS. 119-122.—Palaemonid B.R. IV.

FIG. 119.—Last stage, lateral.

FIG. 121.—Last stage, maxilla.

FIG. 120.—,, maxillipede 1.

FIG. 122.—,, telson.

Maxillule, endopod slender, with two long apical setae. Maxilla, endopod small, with small apical and basal setae, basal lobe not distinct; exopod large without setae on outer margin.

Maxillipede 1, basis protuberant, without spines; endopod unsegmented; exopod with one outer basal seta; epipod not distinctly bilobed. Maxillipede 2, basis protuberant, with two spines. Maxillipede 3, dactyl with one strong apical spine.

Legs 1 and 2 chelate, leg 2 slightly the larger. Leg 4 without exopod, very much longer than 3 and 5; propod with long apical spines. Leg 5 about as long as leg 3, propod and dactyl without spines. Dactyls of legs 3-5 of post-larval stage, seen under skin, apparently simple.

Pleopods large, without setae.

## REMARKS.

This form is included in the *Perichlimenes* series by reason of the great elongation of leg 4 and the general structure of the mouth-parts; but the reduction of leg 5 as compared with leg 4 is a feature hitherto unknown among the Palaemonidae.

## DISCUSSION OF THE PERICLIMENES GROUP.

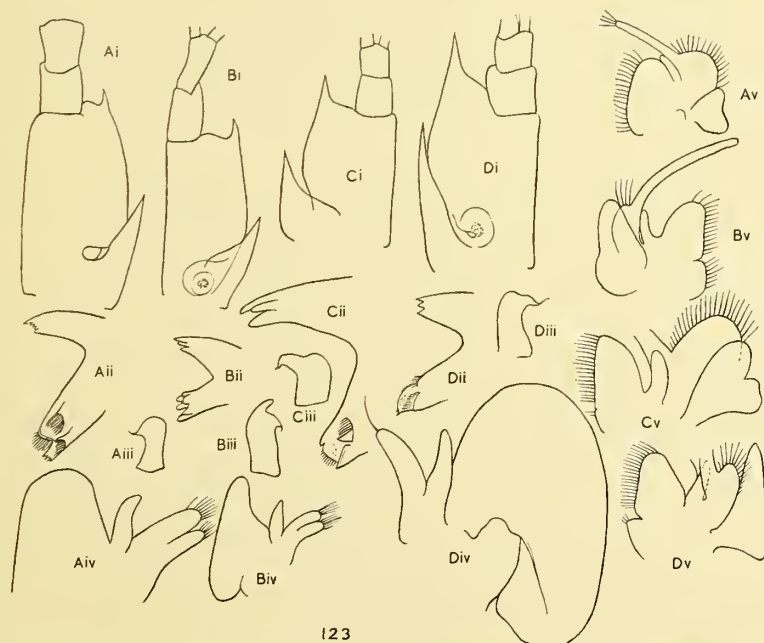
It has been pointed out above (pp. 18, 20) that the larvae of *Periclimenes diversipes* and *Harpilius gerlachei* indicate quite a different generic grouping of the adults from that which is adopted by Kemp. Comparison of the antennule and mouth-parts of such species as are available to me seem to confirm the conclusion drawn from the larvae. The three species of *Periclimenes*, *P. grandis*, *P. agag* and *P. americanus*, agree in almost every detail, the only exception being that I find a podobranch on maxillipede 2 only in *P. grandis*. On the other hand *P. diversipes* differs from all of them in almost every appendage, and in each case approaches much more nearly to *Harpilius beaupresi* or to *Coralliocaris*.

In descriptions of species, or even sometimes of genera, the mouth-parts are often neglected, and as I think some characters of importance in the systematics of the Pontoniinae are available which have not had weight given to them, I give here the facts with regard to these species.

*Antennule and Mouth-Parts of P. diversipes. (Text-fig. 123A.)*

Antennule: Stylocerite without the inner expansion covering the opening of the statocyst found in other *Periclimenes*. The opening is also free in *H. beaupresi* and *Coralliocaris*. It is covered in *Urocaridella gracilis*.

Mandible: The mandibles are not symmetrical, but in *P. americanus*, for example, the molar part on the one side has a series of large blunt teeth, and on the other rounded knobs or ridges with small bristles on one of them. In *P. diversipes*, as in *H. beaupresi* and *Coralliocaris* these teeth or ridges are replaced by a more or less horse-shoe-shaped



TEXT-FIG. 123.—Antennule and mouth-parts of Pontoniinae. A. *Periclimenes diversipes*. B. *P. americanus*. C. *Harpilius gerlachei*. D. *H. beaupresi*. i. Antennule. ii. Mandible. iii. Palp of maxillule. iv. Maxilla. v. Maxillipede 1.

ridge bearing a brush-like arrangement of small spines. The difference is very striking. In *Urocaridella* the mandible is similar to that of *Periclimenes*.

In *Periclimenes* and *Urocardella* the incisor part is much larger in proportion to the molar part.

Maxillule: In *Urocaridella* and *Periclimenes* the palp is bifid at the end, the outer lobe very well defined, whereas in *P. diversipes*, *H. beaupresi* and *Coralliocaris* it is absent.

Maxilla: The lacinia is deeply cleft in *P. diversipes*, as it is in other *Periclimenes*, and in this respect differs from *Harpilius*, where it is narrower and not cleft. In *Coralliocaris* it is narrow, but bilobed. On the other hand the exopod, which is narrow in front in *Urocaridella* and *Periclimenes*, is very broad in *P. diversipes*, *Harpilius* and *Coralliocaris*.

Maxillipede 1: Coxa and basis are separated by a well-marked notch in *Periclimenes* and *Urocaridella*, and the basal expansion of the exopod is not very wide, whereas in *P. diversipes* there is no distinction at all between coxa and basis, and the expansion of the exopod is very wide. In both respects it resembles *Harpilius* and *Coralliocaris*.

Maxillipedes 2 and 3: There is no difference in these appendages sufficiently marked to be defined, but *P. diversipes* is exceptional in having the arthrobranch of maxillipede 3 vestigial, as it is in *Harpilius gerlachei*.

#### *Harpilius beaupresi* and *H. gerlachei*.

While these two species agree in the narrow, uncleft, form of the endopod of the maxilla they differ in the following characters in addition to those mentioned by Kemp.

Antennule: Stylocerite covers the otocyst in *H. gerlachei*.

Mandible: In *H. gerlachei* the incisor process is larger in proportion to the molar part than in *H. beaupresi* and the molar part is intermediate between that of *H. beaupresi*, in which there are no teeth and a granular grinding surface is surrounded by stiff spines, and that of *Periclimenes*, having blunt teeth together with two short rows of spinules.

Maxillipede 1: Coxa and basis very distinct in *H. gerlachei*, scarcely distinguishable in *H. beaupresi*.

Basal expansion of exopod very much less wide in *H. gerlachei*.

Maxillipede 2: Carpus without the sharp spine-like process seen in *H. beaupresi*, and with dactyl much narrower, and spines on it differently arranged.

Maxillipede 3: Arthrobranch vestigial in *H. gerlachei*.

While it seems clear that *P. diversipes* should be transferred to the same genus as *H. beaupresi*, the separation of the latter from *H. gerlachei* is not so fully justified. Borradaile distinguished, on insufficient grounds, *Harpilius* with type *H. lutescens* and including *H. gerlachei*, from *Harpiliopsis*, Borr., with type *H. beaupresi*, and Tattersall, while rejecting Borradaile's genera, suggested that it might be necessary to form a new genus for *H. gerlachei*. With this Kemp did not agree. Having only examined two of the species of *Harpilius* I am not in a position to make any definite proposition on this point, but it is my opinion that the facts strongly support Tattersall's suggestion.

In the later stages of the larva the structure of legs 4 and 5 is the most striking feature of the two species of known parentage, and exactly the same form is found in the species described here under the designations R.S. I, B.R. II, B.R. III, D. III and D. IV. All these forms also agree in the structure of the maxilla, but differ among themselves in



details which may be regarded as specific. The following summary may now be given of the characters of *Ancylocaris* (if *P. diversipes* is excluded) :

- (1) Rostrum small, slender, with few or no dorsal teeth, and without median crest.
- (2) Carapace without hepatic spine and usually without branchiostegal.
- (3) Abdomen without dorsal spines. Anal spine absent.
- (4) Antennule without ventral spine (?).
- (5) Antennal scale, in Stage I, with or without inner papilla.
- (6) Maxilla, endopod with basal lobe : exopod with 4 setae only in Stage I. outer margin bare in later stages.
- (7) Maxillipede 1, basis protuberant, without spines.
- (8) Maxillipede 3, in Stage I, with two long equal spines at end of dactyl.
- (9) Legs 4 and 5 very much longer than leg 3, subequal. Leg 4 without exopod, propod with long terminal spines. Leg 5, propod without long terminal spines : dactyl without inner basal spine.

It is, of course, impossible to say if these characters are distinctive of the subgenus *Ancylocaris* only.

The species described here as B.R. IV seems, from its general form of body and most of the appendages, to belong to *Periclimenes*, but it differs strikingly in the form of the rostrum, and particularly in the very unusual feature of having leg 5 very much smaller than leg 4. It must certainly represent a genus or subgenus distinct from *Ancylocaris*.

#### GROUP II : *Mesocaris*.

While there is no difficulty in accepting the larvae described above as a *Periclimenes* group closely related to each other, the remaining species are very difficult to deal with. There is here no basis of established fact, and it is impossible to determine how far the differences between the larvae are generic or specific. There is one striking feature which characterizes the larval genus *Mesocaris* (see Gurney, 1936, p. 621), namely the acute double flexure of the depressed body and abdomen, and the same flexure is seen in the three forms B.R. V, R.S. II and R.S. IV. They also agree in the general structure of legs 3-5, which are all of about the same length, and in having no basal lobe on the endopod of the maxilla ; but there is no other character common to all. None the less I include them, as a matter of convenience, in a single group.

One of these forms (R.S. IV) is remarkable in having no spine on the antennal scale and, if this is also absent in the adult, it can only be referred to *Onychocaris aualitica*, Nobili, which it also resembles in the reduction of the rostrum.

The two forms R.S. III and B.R. VI diverge greatly from the others. The former has not the flexure of the body characteristic of the group, and the enlargement of the abdominal pleura gives it a very distinct appearance. It is also unlike any other larva in having strong hooked spines on the propod of legs 3-4 instead of the usual straight slender spines. In *Coralliocaris* and other genera the dactyl is curved and provided with a hooked basal claw, but I cannot find any species described as having strong propodal claws. The peculiar modification of these legs does not afford, as one would expect it might, any clue to the genus.

The second larva, B.R. VI, has the body flexed, and the legs of the form usual in *Mesocaris*, but it is remarkable for the great length of the rostrum, of the branchiostegal spine, and of the pleural spines of abdominal somites 1 and 2. Here, again, there is not sufficient ground for identification, but it may be pointed out that there is some general similarity to the strange genus *Coutierea*, Nobili. The single species of this genus, *C. agassizi* (Coutière), was taken at Barbadoes, but there is no reason why the genus should not also occur in the Indo-Pacific. The great length of its rostrum, and antennal (or branchiostegal ?) spines, and the pointed abdominal pleura are striking features of the species. The eyes are overhung by a broadening of the rostrum which is regarded as produced by the connate supra-orbital spines. In the larva the supra-orbital spines are very small, and it may be that they are really lost in the adult and that the covering over the eye is simply an extension of the widening of the rostrum already present in the larva.

MESOCARIS, Ortmann.

Gurney, 1936, p. 621, pls. iii, iv.

Body very much flattened and flexed. Rostrum in late stages with high toothed crest. Carapace with small supra-orbital and with or without antennal and branchiostegal spines, hepatic spine absent. Telson with lateral spines; apical spines 3 + 3 (?). Anal spine absent.

Antennule with ventral spine. Antennal scale in stage I with inner papilla and with outer proximal seta reduced.

Maxilla, endopod with apical seta, without basal lobe; exopod with five setae in stage I, with setae on outer margin in late stages.

Maxillipede 1 in late stages with basis large, not protuberant, without spines; endopod stout, with three distinct segments. Maxillipede 2, basis with two spines, the distal one strong; apical spine of dactyl stout, with conspicuous feathering. Maxillipede 3 with single strong apical spine in all stages.

Leg 4 with exopod; propod with long terminal spines. Leg 5 not markedly longer than leg 4, propod with one long terminal spine; dactyl with or without basal spine.

Palaemonid B.R. V. (Text-figs. 124-133.)

LOCALITY.

Barrier Reef Station 38.

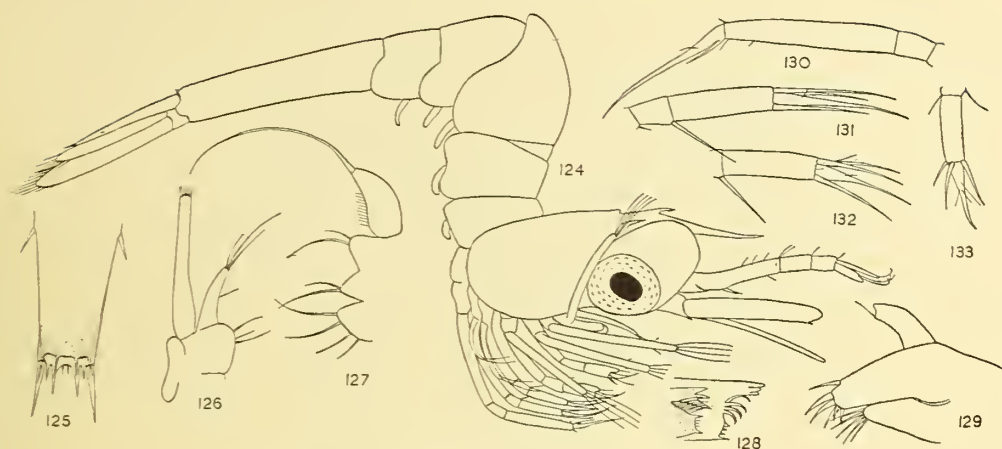
DESCRIPTION.

Stage V? Length 5.6 mm.

Body rather depressed, and sharply bent at thorax and abdominal somite 3. Rostrum as long as segment 1 of antennule, with one dorsal serrated tooth. Carapace with serrated supra-orbital spine and antennal spine. Pleura of abdominal somites 5 and 6 rounded. Anal spine absent.

Telson four times as long as wide, with one pair of lateral and 4 + 4 terminal spines; spines 1 and 3 large.

Antennule, segment 1 with incipient stylocerite and ventral spine; flagella small, unsegmented. Antennal scale narrow, with apical spine; flagellum a little longer than scale.



TEXT-FIGS. 124-133.—Palaemonid B.R. V.

FIG. 124.—Stage V ?, lateral.

FIG. 125.—,, telson.

FIG. 126.—,, maxillipede 1.

FIG. 127.—,, maxilla.

FIG. 128.—,, mandible.

FIG. 129.—Stage V ?, maxillule.

FIG. 130.—,, leg 5.

FIG. 131.—,, „ 4.

FIG. 132.—,, „ 3.

FIG. 133.—,, maxillipede 3.

Maxillule, endopod with one small seta. Maxilla, endopod curved, with one long terminal seta, and no basal lobe or seta ; exopod without setae on outer margin.

Maxillipede 1, basis without spines ; endopod unsegmented. Maxillipede 2 and 3, dactyl with one strong apical spine ; exopods with four setae only.

Legs 1 and 2 subchelate. Leg 4 with exopod, a little shorter than leg 5. Legs 3 and 4 with long spines at end of propod. Leg 5 not greatly elongated, propod without long spines ; dactyl with basal spine.

Pleopods rather large, without setae.

#### Palaemonid R.S. II. (Text-figs. 134-138.)

##### LOCALITY.

Two specimens from plankton at Ghardaqa.

##### DESCRIPTION.

Length 4.55 mm. Last stage.

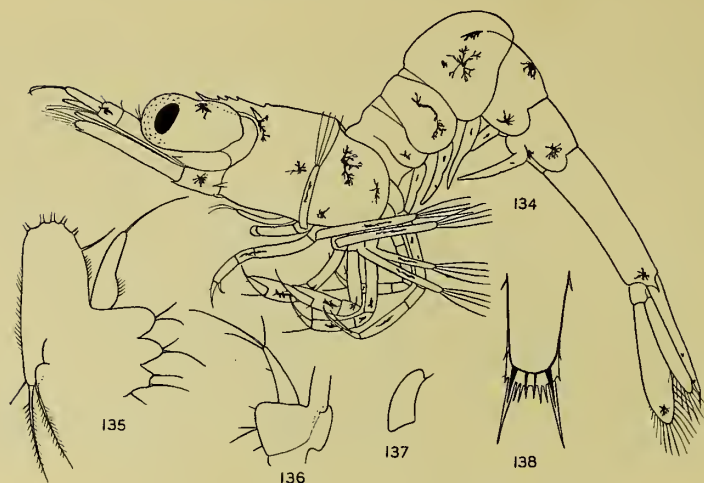
Body sharply flexed at thorax and abdominal segment 3. Rostrum shorter than eye, with three dorsal teeth. Carapace with supra-orbital and branchiostegal spines. Pleura of abdominal somite 5 rounded, somite 6 with lateral spines. Anal spine absent. Telson nearly four times as long as wide, with two pairs of lateral spines and 5 + 5 terminal, of which spine 2 is very long. One of the specimens is about to moult and shows that the two median pairs of spines of the adult arise from spines 2 and 5 of the larva (Text-fig. 133).

Antennule with small stylocerite and ventral spine ; flagella small, unsegmented. Antennal scale with terminal spine ; flagellum as long as scale.

Maxillule, endopod with one very small seta. Maxilla, endopod slender, with long apical seta, but no basal lobe or seta ; exopod without setae on outer margin.

Maxillipede 1, basis not very protuberant, without spines ; endopod unsegmented ; epipod small, not bilobed. Maxillipedes 2 and 3, dactyl with one strong apical spine.





TEXT-FIGS. 134-138.—Palaemonid R.S. II.

FIG. 134.—Last stage, lateral.

FIG. 137.—Last stage, palp of maxillule.

FIG. 135.—,, maxilla.

FIG. 138.—,, telson.

FIG. 136.—,, maxillipede 1.

Legs 1 and 2 chelate, equal; exopod of leg 1 with six setae. Leg 4 a little shorter than 5, without exopod; spines on propod not very large. Leg 5 without long propodal spines; dactyl with basal spine. Pleopods large, without setae.

## REMARKS.

In life this form is even more flexed than is shown in the figure, the thorax and abdomen forming an acute angle and the thorax being parallel to the last three somites of the abdomen. It swims back downwards and tail first.

Colour: General colour to eye whitish yellow, the chromatophores dark olive-brown under microscope, but light yellow in reflected light.

## Palaemonid R.S. III. (Text-figs. 139-145.)

## LOCALITY.

One specimen from plankton at Ghardaqa.

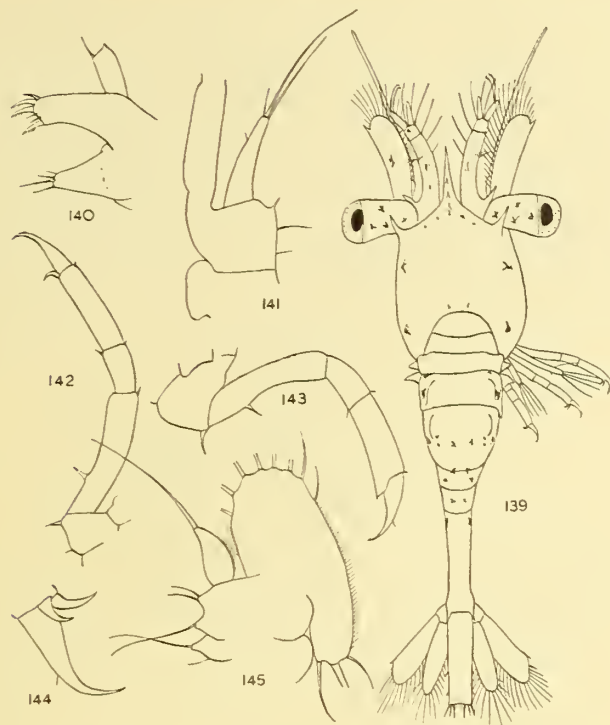
## DESCRIPTION.

Stage IV? Length 4.65 mm.

Body broad and depressed, but not strikingly bent. Rostrum much shorter than peduncle of antennule, with three dorsal teeth. Carapace with supra-orbital, branchio-stegal and pterygostomial spines. Abdominal somites 2 and 3 with pleura pointed and bent outwards so that they are visible from above; somite 3 not swollen dorsally; pleura of somites 4 and 5 rounded; somite 6 with lateral spines. Anal spine absent. Telson parallel-sided, with two pairs of lateral spines and 4 + 4 apical, of which the outer three pairs are subequal.

Antennule, peduncle curved, with large stylocerite and ventral spine; flagella small, unsegmented. Antennal scale broad, with small distal spine; flagellum nearly twice as long as scale.

Maxillule with laciniae widely separated; endopod with one small seta. Maxilla, endites reduced, with few setae; endopod with long apical seta and no basal lobe or seta; exopod very large, without setae on outer margin.



TEXT-FIGS. 139-145.—Palaemonid R.S. III.

FIG. 139.—Stage IV ?, dorsal.

FIG. 140.—,, maxillule.

FIG. 141.—,, maxillipede 1.

FIG. 142.—,, leg 2.

FIG. 143.—Stage IV ?, leg 1.

FIG. 144.—,, „ 4.

FIG. 145.—,, maxilla.

Maxillipede 1, basis not protuberant, with one small spine; endopod unsegmented; exopod with five terminal setae. Maxillipedes 2 and 3 with one large terminal spine; exopods of these and of legs 1-3 with six setae, the proximal pair unequal.

Leg 1 with propod slightly produced; leg 2 without trace of chela, the propod with two stout curved spines at base of dactyl. Legs 3-5 nearly equal, but leg 5 slightly shorter than 4. Legs 3 and 4 have each two strong propodal spines, as in leg 2, while leg 5 has one. Leg 4 with exopod.

Pleopods present as small buds.

#### Palaemonid R.S. IV (*Onychocaris*?). (Text-figs. 146-149.)

##### LOCALITY.

One specimen from plankton at Ghardaqa.

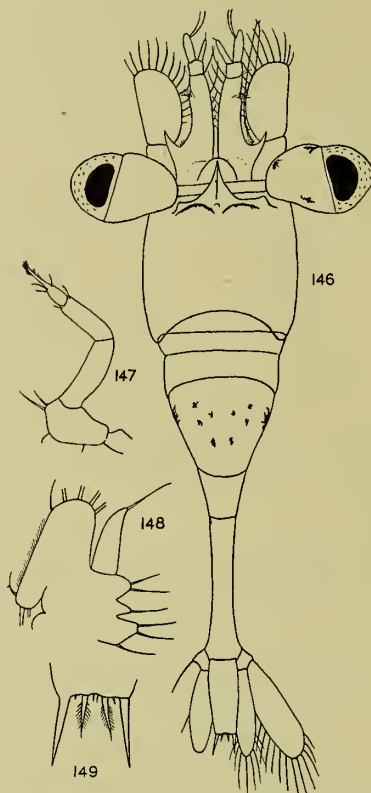
##### DESCRIPTION.

Stage IV? Length 3.5 mm.

Body broad, depressed, much bent at thorax and somite 3. Rostrum very small, triangular in dorsal view, with elevated median crest, without teeth. Carapace with supra-orbital spines reduced to small blunt prominences; branchiostegal and pterygostomial spines absent. Pleura of somites 5 and 6 rounded. Anal spine absent. Telson  $2\frac{1}{2}$  times as long as wide, without lateral spines; end straight, with 4 + 4 spines, of which the outer pair is large and spines 2 and 4 vestigial.

Antennule, peduncle broad at base, with large stylocerite and very small ventral spine. Antennal scale very broad, without spine; flagellum about  $1\frac{1}{2}$  times length of scale.

Maxillule, endites rather wide apart; endopod small, without setae. Maxilla, endopod slender, without basal lobe or seta; exopod without setae on outer margin, narrow proximally. Maxillipede 1, basis slightly protuberant, without spines; endopod two-segmented, with small seta at the joint. Maxillipedes 2 and 3 with single strong terminal spine, that of maxillipede 2 straight, with conspicuous feathering (Text-fig. 147).



TEXT-FIGS. 146-149.—Palaemonid R.S. IV.

FIG. 146.—Stage IV ?, dorsal.

FIG. 148.—Stage IV ?, maxillipede 2.

FIG. 147.—,, maxilla.

FIG. 149.—,, part of telson.

Legs all equally long. Legs 1 and 2 not chelate. Leg 4 without exopod, with two rather stout spines at end of propod. Leg 5 dactyl without basal spine.

Pleopods present, small.

Colour: General colour greenish-yellow.

Palaemonid B.R. VI (*Coutièrea* ?). (Text-figs. 150-154.)

#### LOCALITY.

Barrier Reef Station 13.

#### DESCRIPTION.

Last stage. Length: rostrum, 2.5 mm.; rest of body, 5-15 mm.

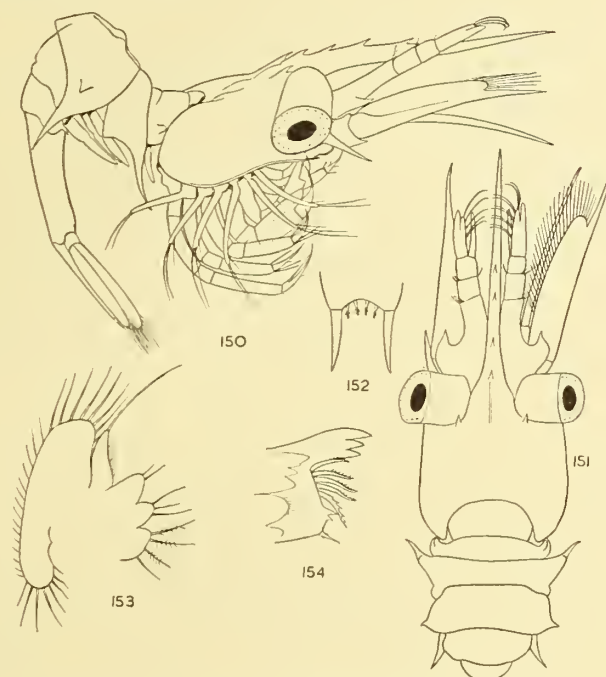
Rostrum with four dorsal teeth, distal part bare. Carapace with small supra-orbital spine and enormous branchiostegal spine. Abdominal somite 1 with papilla on either side; somites 2 and 3 produced into extremely long spines; somite 3 very broad,



depressed dorsally, with pair of small lateral spines; somites 4 and 5 with small pleural spines; somite 6 long and slender, without lateral spines. Anal spine absent. Telson four times as long as wide, without lateral spines; apex with a large outer pair of spines and four small feathered spines between.

Antennule with large stylocerite and small ventral spine; outer flagellum slightly cleft. Antennal scale narrow, with very long apical spine; flagellum about as long as scale.

Mandible with five movable spines. Maxillule, endopod small, curved, with one seta. Maxilla, endopod with long apical seta but no basal lobe or seta; exopod with outer margin fringed with short setae.



TEXT-FIGS. 150-154.—Palaemonid B.R. VI.

FIG. 150.—Last stage, lateral.

FIG. 151.—,, dorsal.

FIG. 152.—,, telson.

FIG. 153.—Last stage, maxilla.

FIG. 154.—,, mandible.

Maxillipede 1, coxa reduced; basis large, without spines; endopod with three distinct segments; exopod with two outer basal setae, four apical setae and one lateral small seta; epipod large, bilobed. Maxillipede 3, dactyl with single large spine.

Legs 1 and 2 chelate, leg 2 the larger. Leg 4 with exopod. Leg 5 a little longer than leg 4, without propodal spines; dactyl with basal spine.

Pleopods large, without setae.

### GROUP III: *Cryptoleander*.

For the three forms now to be described I have coined a name which is not intended as a generic designation but simply as a convenient term for reference. There is a certain general resemblance of these larvae to those of *Leander* and *Retrocaris*, the large serrated dorsal spines and the stout upturned rostrum giving them a marked Palaemonid appearance. As in *Retrocaris* the antennular flagellum becomes cleft in the later stages, and leg 5 is

very long in comparison with leg 4. They differ from the Palaemonid group in the arrangement of propodal spines on leg 5 and in the absence of a basal lobe on the endopod of the maxilla. The branchiostegal spine is also absent.

From the *Periclimenes* group they differ in almost every respect, and they also seem to have no near relation to the *Mesocaris* group, so that they are probably not members of the Pontoniinae at all.

The resemblance to *Anchistioides* in general form is very striking; but there are fundamental differences in the mouth-parts and structure of leg 5 which make it out of the question to include them in that genus. At the same time the resemblance in form seems to point to some degree of affinity and to suggest that *Anchistioides* may be more nearly related to the Palaemoninae than to the Pontoniinae.

If these three forms cannot be included among the known genera of Palaemoninae or Pontoniinae, and do not belong to *Anchistioides*, what remains? The genus or genera to which they belong must be common on the Barrier Reef and exist also in the Red Sea, but it does not necessarily follow that the adults have yet been seen. In a coral-reef region the difficulty in collecting is very great, and there may be many new genera yet to be discovered. As an instance of such difficulty may be mentioned the fact that though *Anchistioides antiguensis* is so commonly seen swimming at night at Bermuda, its real habitat is unknown and it has never been taken there in the daytime. Similarly the larva of *Jaxea nocturna* is not very uncommon at Plymouth but the adult has only once been captured there.

On the other hand it is not impossible that the limit of the family Palaemonidae has been unduly restricted, and that it should be enlarged to include the Gnathophyllidae. The three genera of the family have some remarkable characters special to themselves, and they also have a simple mandible without incisor process. It is the latter fact which has led to the association of Gnathophyllidae, Processidae and Crangonidae into the superfamily Crangonoida, but, if any weight can be given to larval characters then *Processa* is certainly not nearly related to *Crangon*, and the character of the mandible is not decisive. There is, in fact, a tendency to a reduction of the incisor process in some Palaemonidae and Alpheidae. Borradaile (1921) in describing *Paratypton siebenrocki*, Balss, points out certain features in which it resembles *Gnathophyllum*, and concludes "I am inclined to place *Paratypton* near the point to which the Palaemonidae, Anchistioididae and Gnathophyllidae converge". His figure of the mandible seems to indicate that the part regarded as molar is really compounded of the very minute reduced incisor and molar parts, and that the long "incisor part" is, as he himself suggests, a structure *sui generis*.

Apart from the form of the mandible there seems to be less reason to associate Gnathophyllidae with Crangonidae than with Palaemonidae.

It seems not unlikely that the Gnathophyllidae will be found to have larvae of Palaemonid type, and that they may even be among those described here.

#### Palaemonid B.R. VII. (Text-figs. 155-162.)

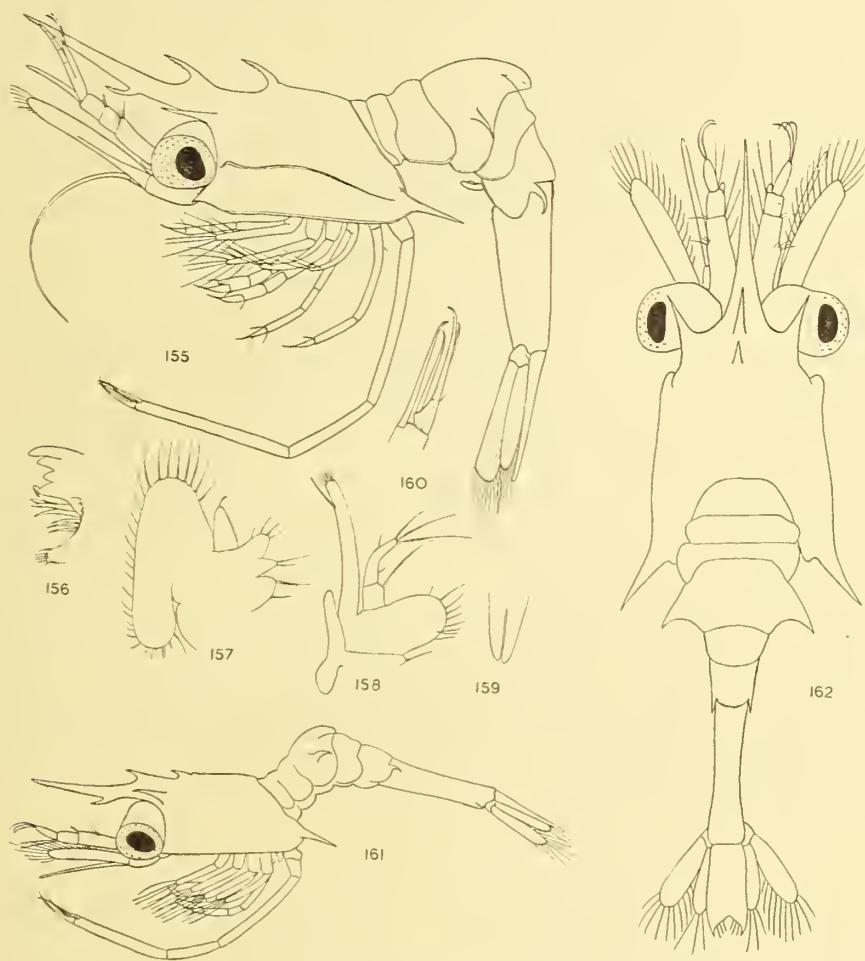
##### LOCALITY.

Barrier Reef Station 14; 6 specimens. Station 46; 1 specimen.

##### DESCRIPTION.

Stage V? Length 8.4 mm.

Rostrum longer than antennule, turned slightly upwards, with serrated spine below about middle, and another dorsal at base. Carapace with one large dorsal serrated spine; a large supra-orbital spine but no antenaul or branchiostegal; posterior angle produced into a large spine. A lateral ridge extends from the orbit nearly to the posterior angle.



TEXT-FIGS. 155-162.—Palaemonid B.R. VII.

FIG. 155.—Stage V ?, lateral.

FIG. 156.—,, mandible.

FIG. 157.—,, maxilla.

FIG. 158.—,, maxillipede 1.

FIG. 159.—Stage V ?, tip of telson.

FIG. 160.—,, part of leg 5.

FIG. 161.—Stage IV ? (Ghardaqa), lateral.

FIG. 162.—,, dorsal.

Abdominal somite 3 somewhat swollen dorsally, with a pair of large lateral spines curving downwards; somite 5 with large curved lateral spines; somite 6 without lateral spines. Anal spine absent. Telson  $4\frac{1}{2}$  times as long as wide, without lateral or terminal spines, but simply bifurcated at end.

Antennule with stylocerite and small ventral spine; outer flagellum deeply cleft. Antennal scale without spine; flagellum about  $1\frac{3}{4}$  times as long as scale.

Maxillule, endopod small, with two small setae. Maxilla, endopod small, with very small apical seta and no basal lobe or seta; exopod with outer margin fringed with setae.

Maxillipede I, basis very protuberant, without spines; endopod of two segments,



segment 1 with long seta ; exopod without basal setae, and five apical. Maxillipede 3, dactyl with single large apical spine ; exopod with eight setae.

Legs 1 and 2 chelate, nearly equal. Leg 4 smaller than leg 3, without exopod, and without long propodal spines. Leg 5 reaching beyond eye ; propod with two very long distal spines ; dactyl with basal spine. Lengths of segments in leg 5 : ischiomerus, 1.7 mm. ; carpus, 1.0 mm. ; propod, 1.6 mm.

Pleopods small.

#### REMARKS.

The Barrier Reef material contains also two other forms which, while agreeing in nearly all respects with the description given above, differ as follows :

Form B. : Stations 55, 57. 3 specimens.

Abdominal somite 3 produced dorsally into a large recurved spine.

Form C. : Stations 33, 53. 2 specimens.

Abdominal somite 3 without dorsal or lateral spines. One of these two specimens measures 10.6 mm. and is rather more advanced, having very large pleopods. The carpus of leg 5 is rather longer in proportion to the propod and ischiomerus.

Some specimens from a plankton sample taken at Ghardaqa in July, 1935 (Text-figs. 156, 157), are younger than those from the Barrier Reef, measuring about 5 mm. Legs 3 and 4 are quite rudimentary, the rudiment of leg 3 biramous, leg 5 fully developed ; there are no pleopods. The telson is parallel-sided, deeply cleft at the end, the arms of the fork narrow and blunt-ended. Within the fork are two pairs of long and a pair of very short setae. Such a form of telson is very unusual and might well develop into the simple cleft form without setae found in the older specimens from the Barrier Reef. When first seen these Red Sea specimens were thought to belong to *Anchistioides*, but dissection of the mouth-parts makes such an identification improbable (see p. 43). I regard them as belonging to the same species as that described above, or at least to one very closely allied to it.

#### Palaemonid B.R. VIII. (Text-figs. 163-169.)

##### LOCALITY.

Barrier Reef Stations 33, 38, 50, 59. 14 specimens.

##### DESCRIPTION.

Stage VI ? Length 6-8 mm.

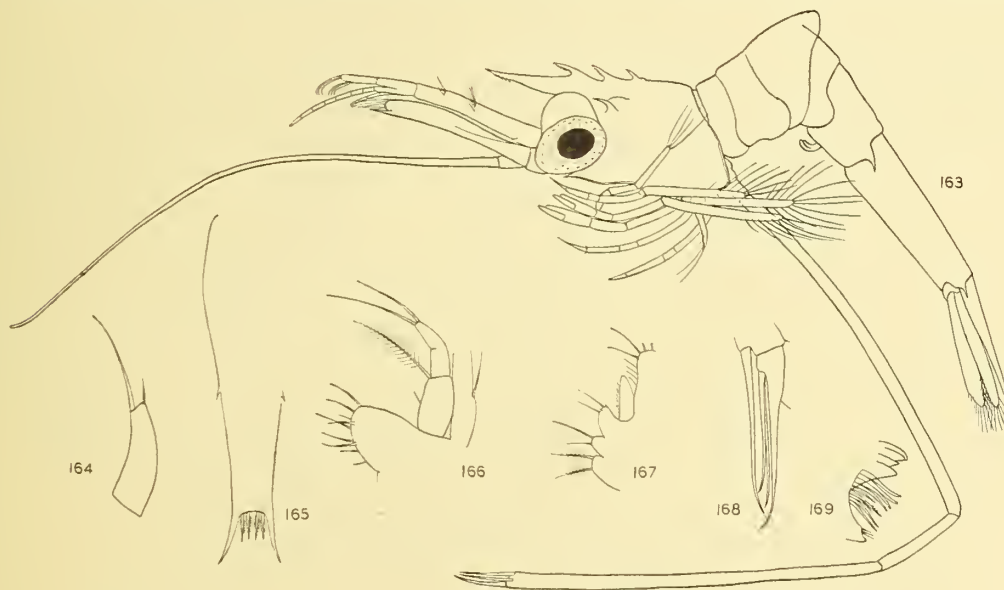
Body rather bent at thorax and somite 3. Rostrum straight, much shorter than peduncle of antennule, serrated at end, and with one dorsal serrated spine. Carapace with two dorsal spines, the anterior one serrated ; supra-orbital and pterygostomial spines present. Abdominal somite 3 projecting over somite 4 ; somites 5 and 6 with lateral spines. Anal spine absent. Telson nearly four times as long as wide, with one pair of lateral spines ; outer apical spines large, forming a fork within which are two pairs of small feathered spines.

Antennule with small stylocerite and very small ventral spine ; outer flagellum deeply cleft, shorter than inner. Antennal scale with long apical spine ; flagellum nearly four times as long as scale.

Maxillule, endopod slender, with two apical setae. Maxilla, endopod without setae or basal lobe ; exopod with outer margin fringed with setae.

Maxillipede 1, coxa without setae; basis very protuberant, without spines; endopod with large basal segment distinct, bearing a long seta, distal part obscurely two-segmented; exopod with one outer basal seta. Maxillipede 2, basis rather protuberant, with two long slender spines; epipod present, small. Maxillipede 3, dactyl with one strong apical spine.

Legs 1 and 2 chelate, leg 2 the larger. Exopods of maxillipede 3 and leg 2 with twelve setae, leg 1 with fourteen. In an older stage than that figured the chela of leg 2 is very long and slender, the dactyl twice as long as the palm. Leg 4 without exopod, slender, shorter than leg 3 and without spines on propod. Leg 5 extremely long; coxa with anterior rounded knob; ischiomerus and propod about equal and about four times as long as carpus; propod with strong distal spines; dactyl with basal spine. Pleopods small.



TEXT-FIGS. 163-169.—Palaemonid B.R. VIII.

- |                                |                                |
|--------------------------------|--------------------------------|
| FIG. 163.—Stage VI ?, lateral. | FIG. 167.—Stage VI ?, maxilla. |
| FIG. 164.—,, maxillule, palp.  | FIG. 168.—,, leg 5, dactyl.    |
| FIG. 165.—,, telson.           | FIG. 169.—,, mandible.         |
| FIG. 166.—,, maxillipede 1.    |                                |

The youngest specimen is only 3.8 mm., but has exactly the same form and spines on rostrum and carapace as the oldest. The uropods are fully developed, but there are no pleopods. While leg 5 is as large in proportion as in later stages, legs 3 and 4 are quite rudimentary. This stage no doubt represents Stage IV, and there is probably one moult between it and the stage figured, which is therefore regarded as Stage VI. An older stage has the pleopods very large, and is no doubt the last stage, so that there seem to be seven stages in all.

#### Palaemonid B.R. IX. (Text-figs. 170-177.)

##### LOCALITY.

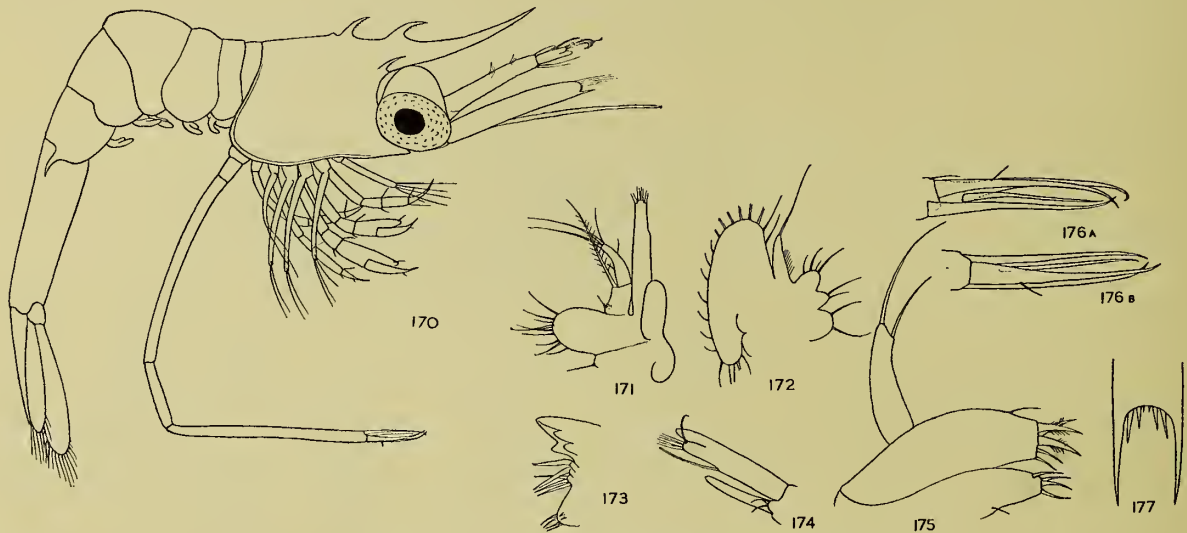
Barrier Reef Stations 2, 9, 38, 44, 53.

##### DESCRIPTION.

Stage V ? Length 8 mm.

Rostrum curving upwards, with one large dorsal spine at base. Carapace with large serrated dorsal spine; supraorbital and pterygostomial spines present. Abdominal somite 3 not swollen dorsally; somite 5 with lateral spines; somite 6 without spines. Anal spine absent. Telson nearly four times as long as wide, without lateral spines, the outer terminal spines very large and forming a fork within which are six small spines.

Antennule with very small stylocerite and large ventral spine; outer flagellum slightly cleft, much longer than inner. Antennal scale with strong terminal spine; flagellum about  $1\frac{1}{2}$  times as long as scale.



TEXT-FIGS. 170-177.—Palaemonid B.R. IX.

- FIG. 170.—Stage V ?, lateral.  
 FIG. 171.— „ maxillipede 1.  
 FIG. 172.— „ maxilla.  
 FIG. 173.— „ mandible.  
 FIG. 174.— „ end of antennule, showing cleft in outer flagellum.  
 FIG. 175.— „ maxillule.  
 FIG. 176.— „ leg 5, dactyl. A. From inside. B. From outside.  
 FIG. 177.— „ end of telson.

Maxillule, endopod slender, with two terminal setae. Maxilla, endopod slender, with long terminal seta but no basal lobe; outer margin of exopod fringed with setae.

Maxillipede 1, coxa with small seta; basis very protuberant; endopod of two segments, segment 1 with long seta.

Legs 1 and 2 chelate, leg 2 the larger, its dactyl longer than palm. Exopods of maxillipede 3 and legs 1 and 2 with six setae. Leg 4 about equal to leg 3, without exopod. Leg 5 very elongated; coxa without inner papilla; ischiomerus and propod equal, about three times as long as carpus. Propod with strong terminal spines; dactyl with basal spine.

Pleopods small.

A younger specimen of 4.9 mm. of same general form and with leg 5 fully developed, had leg 4 a small rudiment.



## 1c. ANCHISTIOIDINAE.

*Anchistioides*.

The larva of *Anchistioides antiquensis* (Schmitt) in Stages I and II (Gurney, 1936) has some remarkable features which make it strikingly distinct from all Palaemonid larvae hitherto described. Apart from the reduction of the mouth-parts, which also characterizes the adult, the posterior spine on the carapace, the very large branchiostegal spine, and the dorsal spine on abdominal somite 3 are features which were not known at the time when the larva was described. While the paper was going through the press I found in plankton from Ghardaqa a Palaemonid larva (described above as B.R. VII, p. 38) with large posterior spines on the carapace which I supposed was a later stage of *Anchistioides*: but examination of the mouth-parts showed that this was an error. That the later stages of *Anchistioides* are in fact much more Palaemonid in appearance than the earliest stages is confirmed by the discovery in the Barrier Reef material of late larvae which can with some confidence be referred to this genus. Two species are represented.

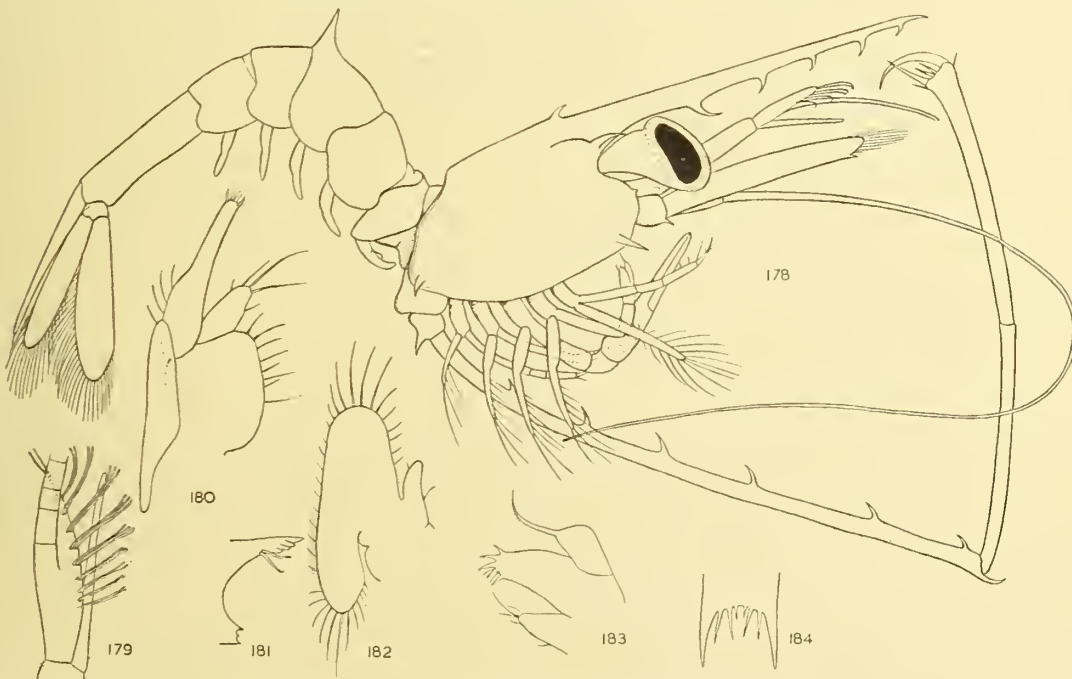
*Anchistioides* Species I. (Text-figs. 178-184.)

## LOCALITY.

Barrier Reef Stations 15, 35, 44. 3 specimens.

## DESCRIPTION.

Last stage? Length 13.5 mm. including rostrum 4 mm.



TEXT-FIGS. 178-184.—*Anchistioides* Species I.

FIG. 178.—Last stage?, lateral.

FIG. 179.—,, part of antennule.

FIG. 180.—,, maxillipede 1.

FIG. 181.—,, mandible.

FIG. 182.—Last stage?, maxilla.

FIG. 183.—,, maxillule.

FIG. 184.—,, end of telson.

Rostrum long and straight, without spines dorsally, but with five ventral spines of which the proximal one points forwards and the distal four backwards. Carapace with small dorsal spine and large supra-orbital and branchiostegal spines. A small projection seems to represent the antennal spine, and there is a small spine at the posterior angle.

Abdominal somite 3 with stout pointed dorsal process; pleura of somites 5 and 6 rounded. Anal spine absent.

Telson tapering,  $4\frac{1}{2}$  times as long as its anterior width; without lateral spines; posterior margin with a pair of strong outer spines confluent with the telson and forming a fork within which are six small spines.

Antennule widened at base, with small rounded process representing stylocerite, without ventral spine; outer flagellum deeply cleft, the thin inner branch reaching end of rostrum (Text-fig. 179), thick sensory part unsegmented. Antennal scale with small distal spine; flagellum very long.

Mouth-parts reduced. Palp of maxillule small, with one curved terminal seta. Maxilla without endites, the endopod small, without terminal seta; exopod large, the outer margin fringed with small setae and hairs.

Maxillipede 1, coxa not distinct, basis not protuberant, with small setae; endopod small, unsegmented; exopod with four outer basal setae, and four terminal. Maxillipede 2 with small rudiment of epipod; endopod of three segments. Maxillipede 3, dactyl with single apical spine; exopod with 14 setae.

Legs 1 and 2 chelate, leg 2 very much larger than leg 1, the dactyl longer than palm. Leg 4 with exopod; endopod smaller than leg 3. Leg 5, basis with posterior spine; ischiomerus enormously produced, with a series of six recurved inner spines; carpus a little shorter than propod, which is slightly dilated at end; dactyl and its spine fused and forming a curved claw apposed to a stout spine on the propod to form a sort of pincer.

Lengths of segments: ischiomerus, 7 mm.; carpus, 2.25 mm.; propodus, 3.15 mm.

Pleopods large, without setae.

### *Anchistioides* Species II. (Text-figs. 185-192.)

#### LOCALITY.

Barrier Reef Stations 24, 26, 40, 44. 6 specimens.

#### DESCRIPTION.

Stage IV? Length 5.45 mm.

Rostrum straight, shorter than peduncle of antennule, with very small ventral tooth. Carapace with large supra-orbital spines, but no branchiostegal spines or spines at posterior angle. Abdomen without dorsal spine; pleura rounded. Telson  $3\frac{1}{2}$  times as long as wide, without lateral spines, and with six feathered terminal spines. Anal spine absent.

Antennule, peduncle with very small ventral spine; flagella small, outer one not cleft. Antennal scale without spine, flagella about as long as body.

Mouth-parts reduced. Maxillule, proximal endite much reduced; endopod small, with one seta. Maxilla without endites; endopod reduced to a small knob; exopod large, without setae on outer margin.

Maxillipede 1, coxa not distinct; endopod with distal segment marked off.

Legs 1 and 2 not chelate. Leg 4 absent. Leg 5 exceedingly large; ischiomerus reaching beyond antennal scale, without spines on anterior margin; carpus long and

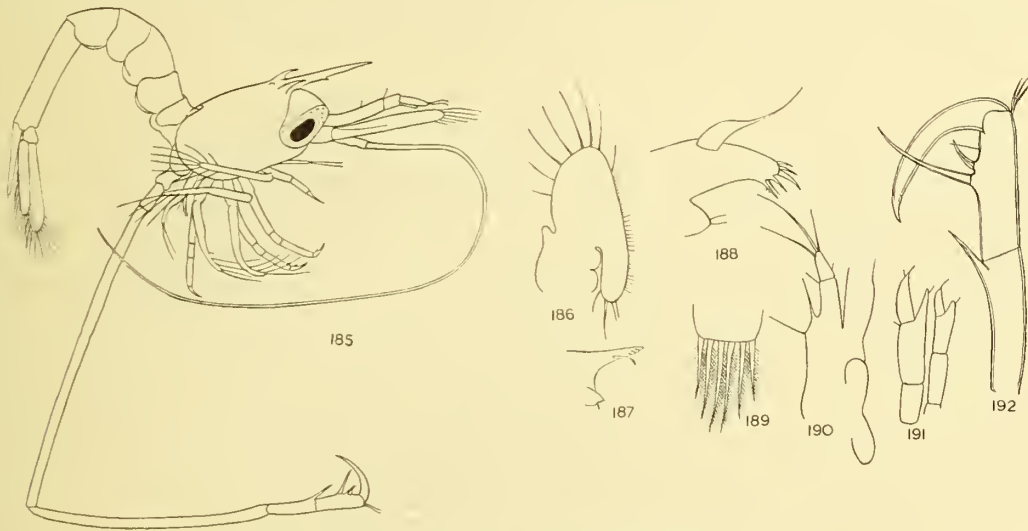
slender: propod divided into two segments with a strong spine at inner distal angle of segment 1; segment 2 not dilated, bearing, as in species 1, a large claw closing on to a strong spine on inner margin of segment.

Pleopods absent. Uropods fully developed, exopod without spine.

Last stage. Length 11 mm., including rostrum 2 mm.

General form of body exactly as in Stage IV. Rostrum with one strong ventral spine; eleven dorsal spines seen under skin, but ventral spines not sufficiently distinct to count.

Antennule, outer branch deeply cleft, with long thin distal flagellum  $1\frac{1}{2}$  times as long as thick basal part, and as long as peduncle. Antennal scale without spine.



TEXT-FIGS. 185-192.—*Anchistioides* Species II.

FIG. 185.—Stage IV ?, lateral.

FIG. 186.—,, maxilla.

FIG. 187.—,, mandible.

FIG. 188.—,, maxillule.

FIG. 189.—Stage IV ?, telson, end.

FIG. 190.—,, maxillipede 1.

FIG. 191.—Stage V ?, legs 1 and 2.

FIG. 192.—Stage IV ?, end of leg 5.

Legs 1 and 2 chelate, leg 2 much larger than leg 1; dactyl shorter than palm; exopods with 18 setae. Leg 4 the same size as leg 3, without strong spines on propod, with exopod.

Leg 5, lengths of segments: ischiomerus, 6.4 mm.; carpus, 5.15 mm.; propodus, 1.65 mm.

Pleopods large.

An intermediate stage of 7.65 mm. has the pleopods present as small buds, and leg 4 a small rudiment.

#### REMARKS.

One of the late stages here described agrees with the earlier stages of *A. antiquensis* in having a dorsal spine on the abdomen, and it also has the same peculiar form of the mouth-parts, so that it can hardly be doubted that it belongs to the same genus, though there are great differences in the form of the carapace. In both the species described hypertrophy of leg 5 has produced an appendage of fantastic size, and terminating in a claw of remarkable construction. Such hypertrophy of leg 5 is characteristic of the



Palaemonidae, and the larva has in fact the general facies of the Palaemonidae of the *Leander* and *Cryptoleander* groups, though it differs radically in form of the mouth-parts. Apart from the fact that the mouth-parts are rather more reduced in the Pontoniinae than in the Palaemoninae there is nothing to suggest that *Anchistioides* is more nearly related to the Pontoniinae.

Miss Gordon has discussed the systematic position of the genus and concludes that it is a true Pontoniid, but I suggest that it would be more satisfactory to regard it as forming a distinct subfamily. Having regard to the great difference between the larvae of *Ancyllocaris* and those described here in the *Mesocaris* group it seems possible that, even within the Pontoniinae, some separation of genera into subgroups is required; but naturally nothing can be suggested until more of these larvae can be attached to their genera.

## II. ALPHEIDAE.

The development of the Alpheidae is fairly well known through the work of Herrick, Sars, Coutière, Webb and Lebour. There is a strong tendency in the genus *Synalpheus* to abbreviation of development, and this is also seen in some species of *Alpheus*, but many, and perhaps most, of the species of *Alpheus* hatch as a perfectly normal zoea and pass through as many as nine larval stages (Lebour, 1932). The structure of the larva in such cases is remarkably uniform. Development is known in species of *Alpheus*, *Synalpheus* and *Athanas*, and examination of the eggs of other genera by Coutière indicates that the larva resembles that of *Alpheus*, and that development is not abbreviated. Such unidentified Alpheid larvae as are known (*Anebocaris*, *Diaphoropus*, Bate) do not differ to any very marked extent from those of *A. ruber*, for example, but *Anebocaris ancylifer*, Coutière, is remarkable for its size (16 mm.) and is one of those large oceanic larvae which Bouvier and Coutière suggest continued their larval phase far beyond the normal period.

This uniformity of structure is rather remarkable in view of the diversity of form within the nearly allied family of Palaemonidae, and it is desirable to add to our knowledge by description of more larvae of known parentage. The form described below as Alpheid R.S. II shows that there is some diversity, but unfortunately this larva cannot be named.

The Red Sea is extremely rich in Alpheids, as Coutière has shown, but I was not very successful at Ghardaqa in obtaining larvae. A number of species were found, but some were not breeding or had only just begun to breed, and it seems that Alpheids are peculiarly difficult to deal with in the laboratory, being very apt to throw off their eggs without hatching. Of one small species which is abundant in the coral many females were kept, some of them for many days, but not one of them produced larvae.

### *Alpheus ventrosus*, M. Edw. (Text-figs. 193-198.)

#### LOCALITY.

This is a large, dark red, species found very commonly in the branches of the coral *Stylophora* at Ghardaqa, generally a male and a female together. The eggs are numerous and not large in proportion to the size of the animal. In a female of 34 mm., with early eggs, the eggs measure .87 mm. by .62 mm. For the most part the eggs were all in early stages, but those of one female hatched out in the laboratory on 23rd March.

## DESCRIPTION.

Stage I. Length 2.4 mm.

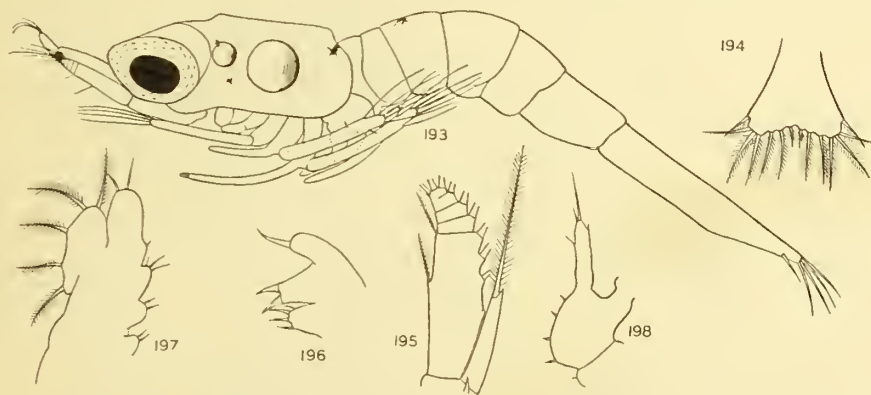
Rostrum absent. Carapace and abdomen without spines; telson triangular, not deeply indented, with 7 + 7 spines.

Eyes sessile, oval in dorsal view.

Antennule unsegmented. Antennal scale with four distal segments and ten inner and apical setae; endopod less than half length of scale, with apical seta and small spine; basis with small spine. Mandible rudimentary.

Maxillule very small, lacinia 2 with two large spines. Maxilla with endites very reduced and endopod not marked off from stem; exopod small, with five setae.

Maxillipede 1, endopod unsegmented, basis large, protuberant, with four small spines. Maxillipedes 2 and 3, endopods unsegmented, without setae. Exopods with six setae; in



TEXT-FIGS. 193-198.—*Alpheus ventrosus*.

FIG. 193.—Stage I, lateral.

FIG. 194.— „ telson.

FIG. 195.— „ antenna.

FIG. 196.—Stage I, maxillule.

FIG. 197.— „ maxilla.

FIG. 198.— „ maxillipede 1.

maxillipede 2 the proximal seta on the posterior side is reduced to a small hair. Behind the maxillipedes are two large leg rudiments, representing a biramous leg 1 and leg 5.

Colour: All the specimens were almost colourless. Only four small red chromatophores could be seen, but there was some diffuse yellow in the stomach region.

*Alpheus audouini*, Coutière. (Text-figs. 199-203.)

## LOCALITY.

*A. audouini* is very common on the tidal reef-flat at Ghardaqa, where it lives under stones and in crevices in the coral rock. The snapping of its claws can be heard everywhere, but it is not easy to catch, since the rock is honey-combed with holes into which it disappears. It must also be very common in burrows in sand in deeper water since it was taken in some numbers when trawling over the *Halophila* bed at night, though never caught there by day.

## DESCRIPTION.

Stage II. Length 2.75 mm.

Carapace with small pointed rostrum and pterygostomial spine. Telson triangular, posterior margin straight, with 8 + 8 spines.

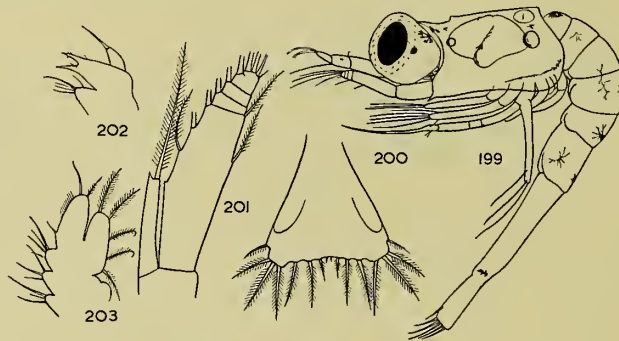
Eyes stalked. Antennule with segment 3 of peduncle distinct; exopod with one large and four slender aesthetes and a delicate hair, but no feathered seta. Antennal scale with four distal segments and 10 inner and apical setae; a small knob on inner edge between setae and base; endopod less than half length of scale, with apical seta and small spine.

Mandible small, but with teeth. Maxillule very small, with two large spines on segment 2. Maxilla with three well-marked endites bearing small setae; endopod with vestige of basal lobe; exopod small, with five setae.

Maxillipede 1, endopod very small, with apical seta. Maxillipede 2, endopod of four segments, with apical spine. Maxillipede 3, endopod very long and slender, with long apical spine; exopods with 4.6.6 setae.

Leg 1 a large biramous rudiment without setae. Leg 2 a small biramous rudiment; leg 3 a small papilla; leg 4 absent. Leg 5 a large, blunt-ended rod.

Uropods traceable within telson.



TEXT-FIGS. 199-203.—*Alpheus audouini*.

FIG. 199.—Stage II.

FIG. 202.—Stage II, maxillule.

FIG. 200.—,, telson.

FIG. 203.—,, maxilla.

FIG. 201.—,, antenna.

#### REMARKS.

Among large numbers of specimens from two broods nearly all are as described above. Two only were found partially moulted from a normal Stage I, having sessile eyes and telson with 7 + 7 spines.

All breeding females were examined every morning and evening, and it is clear that in this case there is a first stage which moults within a few hours into Stage II. Brooks and Herrick (1892, p. 361) noted the very short duration of Stage I in *A. minor* (= *A. bermudensis*, Bate) and it may be well that this is usual in the Alpheidae. Miss Lebour (1932) found that the first larva in *Athanas nitescens* and *Alpheus ruber* had the rostrum and stalked eyes characteristic of Stage II, and it seems likely that here also Stage I has already been passed through. There must, however, be some variation in this respect since Miss Webb (1921) found a normal Stage I of *A. nitescens* in plankton.

I have described (1927) three stages, including a normal Stage I of this species from the Suez Canal. Though the identification was then only a matter of guesswork I have no doubt now that it was correct.

Development probably proceeds as in *A. ruber* through a number of stages, but no later larvae which could be attributed to it were seen at Ghardaqa. Larvae of another species, distinguishable by the presence of a supra-orbital spine, were common in plankton from outside the reefs, but not seen in the lagoon. I attribute these with much doubt to *A. pacificus*, Dana.



*A. pacificus*, Dana ? (Text-figs. 204-214.)

Coutière, 1905, p. 909.

## DESCRIPTION.

Larva in last stage. Length 6.3 mm.

Carapace with rostrum shorter than eyes and with supra-orbital and pterygostomial spines. Abdominal pleura rounded; somite 6 more than twice as long as deep. Telson more than three times as long as wide, without lateral spines, and with 4 + 4 apical spines, of which the outer pair are very long. Anal spine absent.

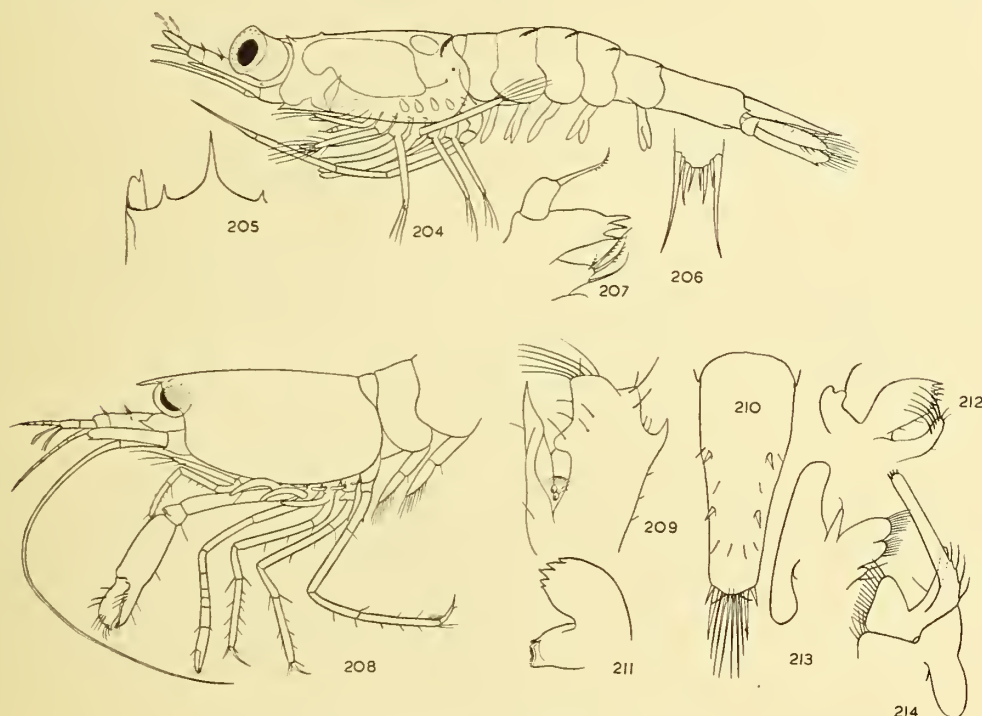
TEXT-FIGS. 204-214.—*Alpheus pacificus* ?

FIG. 204.—Last stage.

FIG. 205.—,, carapace from above.

FIG. 206.—,, end of telson.

FIG. 207.—,, maxillule.

FIG. 208.—Post-larval I.

FIG. 209.—,, antennule.

FIG. 210.—Post-larval I, telson.

FIG. 211.—,, mandible.

FIG. 212.—,, maxillule.

FIG. 213.—,, maxilla.

FIG. 214.—,, maxillipede 1.

Endopod of antenna longer than scale, with basal segment distinct. Mandible without palp.

Maxillule, endopod small with large apical seta; lacinia 2 with three strong spines. Maxilla, exopod with outer margin without setae; endites with several setae; endopod with basal seta.

Maxillipede 1, basis with four marginal spines.

Legs 1 and 2 indistinctly segmented, with small chelae. Leg 5 reaching with its apical spine to beyond the eyes.

Epipods present on legs 1-4.

Pleopods large, without setae. Uropods, exopod with small outer apical spine.

Colour : Bright yellow below eyes, in labrum and at bases of maxillipede 3 and leg 3. Two small red chromatophores at posterior end of carapace, and larger ones dorsally in abdominal somites 1-4.

From this stage moults were obtained to post-larval.

Post-larval Stage I. Length 6 mm.

Carapace with small rostrum, and partly, but not wholly, overhanging the eyes. Telson nearly three times as long as wide, with two pairs of dorsal spines and two pairs of terminal spines, between which there are three pairs of long feathered setae. Anal spine absent.

Antennule, segment 2 longer than segment 3 (42 : 30) ; segment 1 with large inner spine and sharp-pointed stylocerite ; otocyst widely open above (Text-fig. 209). Mandible without palp.

Mouth-parts and maxillipedes of adult form. Maxillipede 1 and 2 with epipod ; maxillipede 3 with rudiment of arthrobranch ; epipods on legs 1-4. The exopod of maxillipede 3 bears setae, and is not reduced as is so often the case in post-larval Stage I.

Leg 1 on left with very large chela, the dactyl about two-thirds length of palm and broadening near end. Right chela slender, the dactyl nearly as long as palm. Leg 2 carpus of five segments of following lengths—30, 19, 13, 12, 27.

Legs 1-3 with spine on posterior margin of ischium ; dactyl simple and slender.

Colour : Almost colourless, but with yellow in same places as in larva.

#### REMARKS.

It is not to be expected that the specific characters of the adult would be developed at this stage sufficiently for correct identification, especially in so difficult a genus. The form of the chela is probably more or less like that of the adult, at least in its general proportions ; but the carpus of leg 2 certainly becomes more slender and the proportional lengths of the segments may also change. Assuming, however, that these proportions may be relied upon, most of the species known from the Red Sea are excluded, since it is more usual to find segment 1 shorter than segment 2 throughout the genus. In *A. pacificus*, according to Coutière, segments 1 and 2 have the proportions 1.27 : 1, whereas they are 1.58 : 1 in my specimen. The general form of the dactyl of the large chela is the same, though the propod is very much stouter in the adult *A. pacificus*.

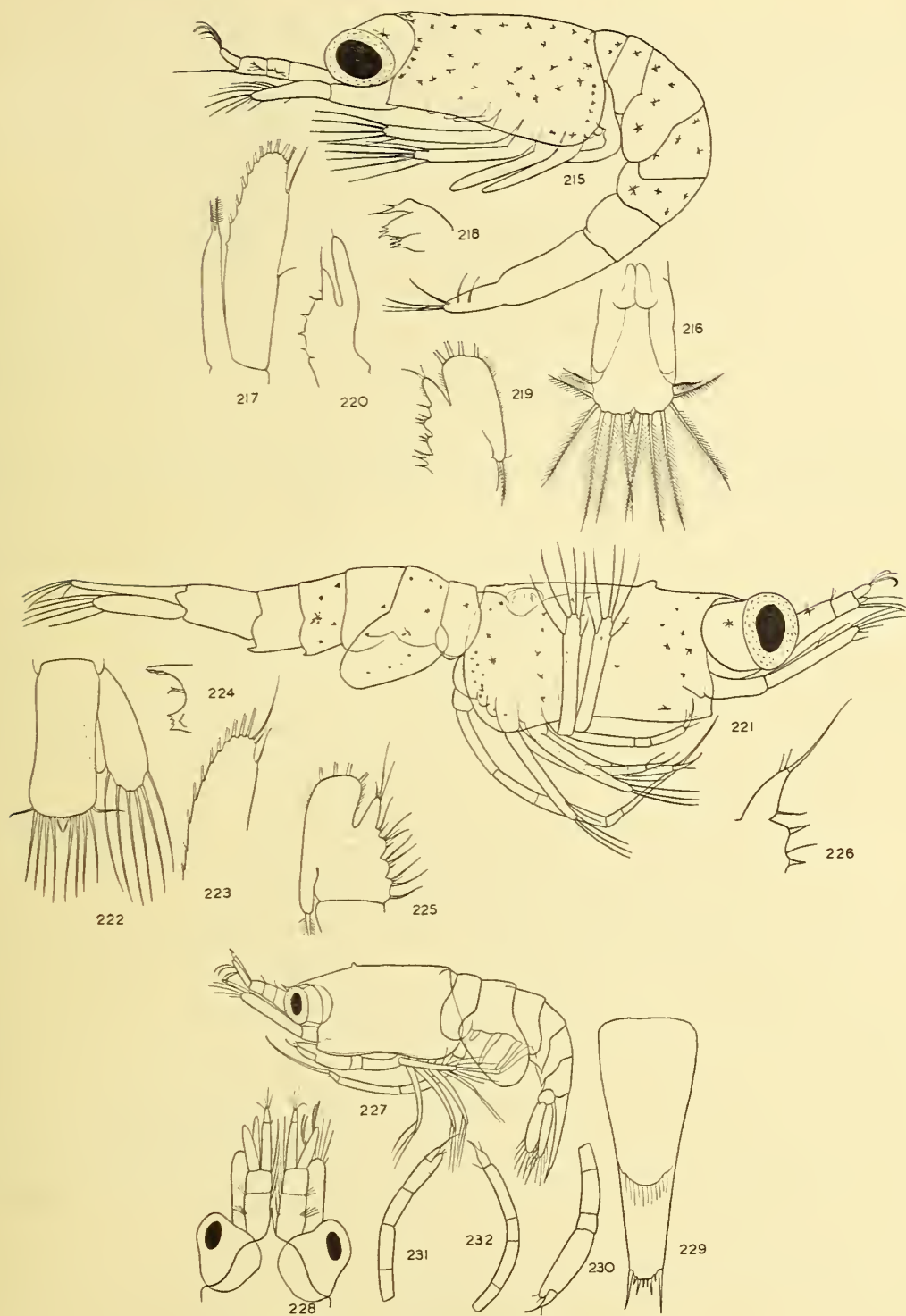
#### *Synalpheus triunguiculatus* (Paulson). (Text-figs. 215-232.)

#### LOCALITY.

This small, dark-red Alpheid was found in small numbers on the inner reefs at Ghardaqa in coral of the genus *Stylophora*.

One female hatched eggs on 23rd March. A number of the larvae moulted two days later to Stage II, and one specimen in Stage II and another in Stage III or IV were taken in plankton.

Coutière (1899, p. 450) regards *S. triunguiculatus* as a variety of *S. neptunus*, Dana. Both are common at Djibouti, but *S. neptunus* is found generally in sponges, and has large eggs, with a very advanced egg-larva, while he found *S. triunguiculatus* living in *Stylophora* and having smaller eggs, with a zoea larva. He noted the large size of the pleura of somite 2 (p. 455).

TEXT-FIGS. 215-232.—*Synalpheus triungiculatus*.

- |                              |                               |
|------------------------------|-------------------------------|
| FIG. 215.—Stage I.           | FIG. 224.—Stage II, mandible. |
| FIG. 216.— „ telson.         | FIG. 225.— „ maxilla.         |
| FIG. 217.— „ antenna.        | FIG. 226.— „ maxillipede 1.   |
| FIG. 218.— „ maxillule.      | FIG. 227.—Stage IV ?          |
| FIG. 219.— „ maxilla.        | FIG. 228.— „ head, dorsal.    |
| FIG. 220.— „ maxillipede 1.  | FIG. 229.— „ telson.          |
| FIG. 221.—Stage II.          | FIG. 230.— „ leg 1.           |
| FIG. 222.— „ telson.         | FIG. 231.— „ „ 2.             |
| FIG. 223.— „ antennal scale. | FIG. 232.— „ „ 3.             |



## DESCRIPTION.

## Stage I. Length 2.5 mm.

Rostrum very broad, shorter than eyes, abruptly narrowed at end into a small point. Carapace without spines or marginal teeth. Abdominal somite 2 with conspicuously large pleura. Telson very narrow, nearly rectangular, setae 1 and 2 directed outwards and forwards, setae 3-5 very long; seta 2 feathered on both sides. Eyes free.

Antennule with peduncle segmented. Antennal scale unsegmented, with two outer and ten inner and terminal setae; a very small tubercle on inner margin next to proximal seta; endopod more than half as long as scale, with two short apical setae. Mandible rather rudimentary, but showing distinction of incisor and molar parts. Maxillule very small, but with spines on endites. Exopod of maxilla with four setae in front and one large proximal seta; endopod with rather large basal lobe; three endites with small spines.

Maxillipede 1 much reduced; exopod without setae; basis with four small spines. Maxillipedes 2 and 3, endopod unsegmented, without setae; exopods with 5 and 6 setae, four apical.

Legs 1 and 2 rudimentary, the exopods large, without setae. Leg 5 very long, turned forwards, without apical spine.

## Stage II. Length 2.6 mm. Specimen from plankton 2.87 mm.

Rostrum broad at base, narrowed in front into an upturned spine. Abdominal somite 2, pleura very large and partly covering somites 1 and 3. Pleura of somites 4 and 5 with ventral point. Telson jointed to somite 6, parallel-sided, more than twice as long as wide, without lateral spines and with only 7 + 7 apical setae, of which the innermost is minute. Anal spine absent.

Antennule with very small endopod; base not enlarged. Antennal scale with 13 inner and apical setae and only one outer seta; endopod with two apical setae.

Mouth-parts almost unchanged; exopod of maxilla the same.

Maxillipede 1, exopod without setae. Exopods of maxillipedes 2 and 3 with six setae; endopods with setae and terminal spine. Legs 1 and 2 fully formed; legs 3 and 4 rudimentary. Leg 5 very long, with long smooth apical spine.

Uropods developed; exopod not jointed to basis, with six setae; endopod jointed, without setae.

This stage is equivalent to the normal Stage III, and this appears to be another case of the omission of the ordinary Stage II. In view of my observation of the very short duration of Stage I in *A. audouini* it seems probable that there is a similar speeding-up of metamorphosis in *S. triunguiculatus*, but my attention was not directed to this point on the spot, and I have no evidence of this supposed first moult.

## Stage III (or IV?). Length 5.0 mm.

Rostrum and carapace unchanged. Abdominal somites 4 and 5 with sharply-pointed pleura. Telson very long and narrow, without lateral spines, and with 4 + 4 apical spines. Anal spine present.

Antennule, endopod longer than exopod, with small apical segment. Endopod of antenna longer than scale, with proximal and distal segments marked off; scale without apical spine. Mouth-part apparently unchanged.

Legs 1 and 2 with large chelae; legs 3 and 4 fully developed, with exopods. Leg 5 with long spine reaching beyond eyes. Pleopods present, pleopod 1 very small.

This specimen, which is rather decayed and damaged, was about to moult to post-larval. It is so much further advanced in development than Stage II that there is probably an intermediate stage which was not found. Assuming also a missing Stage I, there would then be five stages in all, as in some Palaemonidae.

Alpheid R.S. I. (Text-figs. 233–237.)

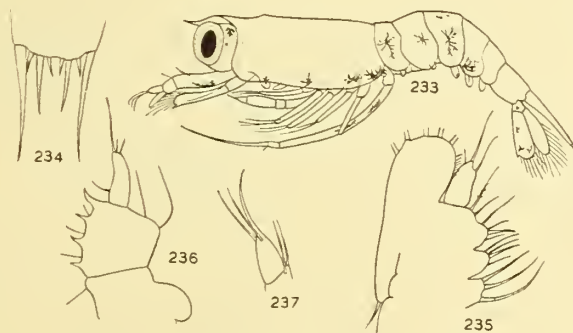
LOCALITY.

Ghardaqa plankton.

DESCRIPTION.

Length 3.7 mm.

Rostrum large and broad, longer than eyes, and overhanging them. Carapace and abdomen without spines; pleura rounded. Telson nearly three times as long as wide, without lateral spines; with 4 + 4 apical spines of which the outer pair are very long. Anal spine present.



TEXT-FIGS. 233–237.—Alpheid R.S. I.

FIG. 233.—Stage IV ?

FIG. 234.—,, telson.

FIG. 235.—,, maxilla.

FIG. 236.—Stage IV ?, maxilliped 1.

FIG. 237.—,, leg 3, dactyl.

Antennule with minute rudiment of stylocerite, but not widened at base. Antennal scale with small apical spine; endopod a little shorter than scale, without basal segment; basis without spine. Mandible small but toothed.

Maxilla with three well-developed endites; endopod without basal seta; exopod with four large setae anteriorly, outer margin smooth, narrowed behind and bearing here one small seta.

Maxilliped 1, endopod small, unsegmented; basis with four very large marginal spines; rudiment or epipod present. Maxillipedes 2 and 3 endopods normal, with four segments; exopods with six setae.

In the single specimen seen legs 1 and 2 are large and chelate on the right side, but without chelae on the left, though the propods are enlarged. Legs 3 and 4 alike, with short dactyl and apical spine (Text-fig. 237). Leg 4 with exopod without setae. Leg 5 very long and slender, reaching with its spine to end of eyes.

Pleopods present, small. Uropods well developed, exopod with 12 setae, and endopod with 10.

Colour : General colour olive-brown, but with red in the chromatophores on somite 4 and at base of leg 3.

Antennule yellow.

#### REMARKS.

While this is quite certainly an Alpheid larva, and very closely resembles the larva of *Synalpheus*, the absence of setae from the exopod of leg 4 is peculiar and the asymmetry of legs 1 and 2, if it is not merely abnormal, is so unusual a feature that I feel this larva may belong to another genus altogether.

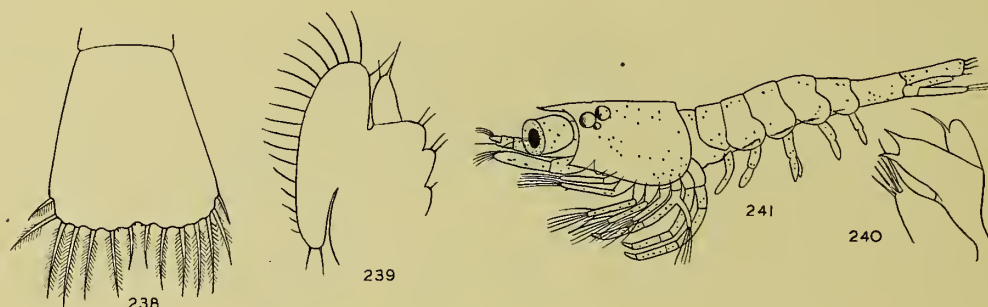
### Alpheid R.S. II. (Text-figs. 238-241.)

#### LOCALITY.

Ghardaqa plankton.

#### DESCRIPTION.

Stage II ? Length 4.45 mm.-4.9 mm.



TEXT-FIGS. 238-241.—Alpheid R.S. II.

FIG. 238.—Stage II, telson.

FIG. 239.—,, maxilla.

FIG. 240.—Stage II, maxillule.

FIG. 241.—Stage III.

Carapace with small rostrum ; anterior angle pointed. Telson segmented from somite 6, about as wide as long, with 7 + 7 spines and in one case a minute median tubercle which may represent spine 8.

Eyes stalked. Antennule, peduncle of three distinct segments, endopod as long as exopod. Antennal scale unsegmented, with small spine and many setae ; endopod longer than scale, stout, with basal segment distinct, and also a small distal segment. Mandible small, but with toothed incisor part. Maxillule, segment 2 with two large spines. Maxilla with endites reduced ; endopod with two setae ; exopod fringed with setae.

Maxillipede 1, basis with four spines, epipod present. Maxillipedes 2 and 3 with very small apical claws.

Legs 1 and 2 chelate, leg 1 much larger than 2. Legs 1-3 with exopods, without setae. Leg 5 not larger than 4.

Stage III ? Length 4.5-4.8 mm.

Carapace as before. Telson widest at end, with 6 + 6 spines. No anal spine.

Mouth-parts and thoracic appendages unchanged except that chelae are larger and exopods on legs 1-3 have setae. In one specimen near moulting the right chela is very much the larger, and has a large knob on the inner edge of the dactyl.



Pleopods large, with incipient setae. Uropods present, the endopod not jointed and without setae.

Colour: General ground-colour greenish-yellow, with black dots and a few red chromatophores. Median ventral chromatophores in abdomen red.

One specimen of Stage III died in the moult to post-larval, but the new stage is not sufficiently free from the old skin to show its characters. It can, however, be seen that there is a rudimentary arthrobranch on maxillipede 3 and no epipods on the legs.

#### REMARKS.

The general resemblance of this larva to that of "*Alpheus sauleyi* var. *brevicarpus*" described by Herrick is very close, and this, with the absence of epipods from the legs make it practically certain that it is the larva of a species of *Synalpheus*. It differs from Herrick's species in having no exopod on leg 4, and from *S. triunguiculatus* in the same way, but also in general form and in having leg 5 not specially elongated. It is, in fact, a quite distinct type of larva, and it is unfortunate that it cannot be identified.

Only the two stages described were seen, and moults were obtained of Stage II to Stage III. If there is an earlier stage it is, no doubt, a transitory one; but, in any case development is much shortened since "Stage III" is certainly the last larval stage. There seems to be no growth between the stages, the larva probably living on yolk and not by capture of food.

#### Alpheid B.R. I. (Text-figs. 242-248.)

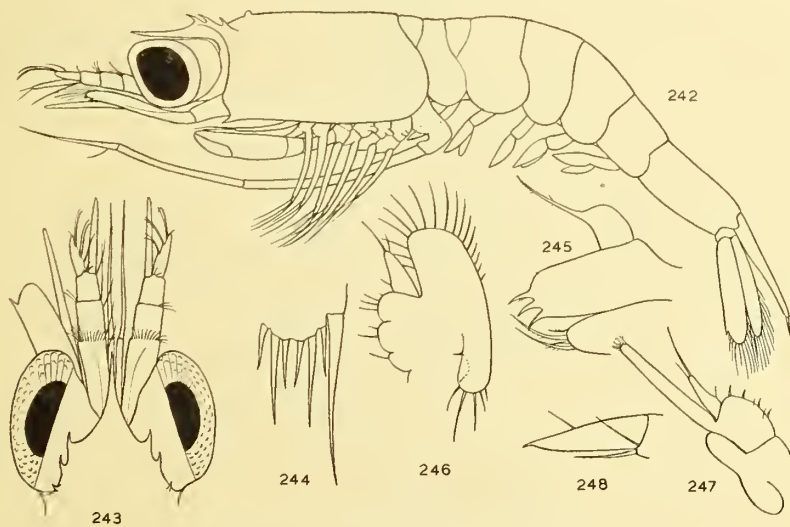
##### LOCALITY.

Barrier Reef Station 50.

##### DESCRIPTION.

Length 7.55 mm.

Rostrum as long as eyes, very broad at base where it bears three large marginal



TEXT-FIGS. 242-248.—Alpheid B.R. I.

FIG. 242.—Last stage.

FIG. 243.—,, dorsal view of head.

FIG. 244.—,, end of telson.

FIG. 245.—,, maxillule.

FIG. 246.—Last stage, maxilla.

FIG. 247.—,, maxillipede 1

FIG. 248.—,, leg 4, dactyl.

teeth on either side. Carapace with pterygostomial spine. Abdominal pleura rounded. Telson four times as long as wide, without lateral spines and with 4 + 4 terminal spines, of which the outer pair are very long. Anal spine absent.

Antennule with stylocerite, without ventral spine; endopod longer than exopod. Antenna, endopod longer than exopod with basal segment distinct. Mandible small, but with teeth. Maxillule, lacinia 2 with three large spines. Maxilla, endopod with basal seta; exopod with part of outer margin bare.

Maxillipede 1, basis with four small spines; epipod very large. Maxillipede 2, endopod of four segments, with strong apical spine; epipod small. Legs 1 and 2 with chelae. Legs 1-4 with exopods; epipods on legs 1-4. Leg 5 extending with spine beyond antennules.

Pleopods large, without setae. Uropods fully developed.

#### REMARKS.

One specimen of this Alpheid was found in a plankton sample from Station 50 of the Great Barrier Reef Expedition. While it is in other respects a perfectly normal larva of the *Alpheus* type it differs from all other known larvae in the strongly toothed margins of the rostral hood.

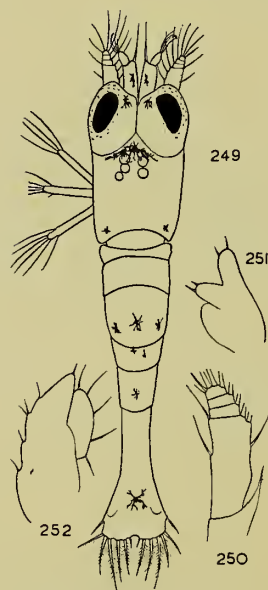
#### *Athanas djiboutensis*, Coutière. (Text-figs. 249-252.)

#### LOCALITY.

The adult is found commonly in pools on the reef-flat at Ghardaqa, but only one was taken with eggs. From these rather large eggs about 15 larvae were hatched on 25th March.

#### DESCRIPTION.

Stage I. Length 1.5 mm.



TEXT-FIGS. 249-252.—*Athanas djiboutensis*.

FIG. 249.—Stage I.

FIG. 250.—,, antenna.

FIG. 251.—Stage I, maxillule.

FIG. 252.—,, maxilla.

Rostrum absent; carapace and abdomen without spines. Telson rather narrow, slightly indented, with 7 + 7 setae, of which the fourth is the longest.

Peduncle of antennule unsegmented. Antennal scale segmented, with two outer and ten inner and terminal setae; endopod a short spine-like process. Mandible rudimentary. Maxillule and maxilla very much reduced, apparently not functional, with few setae.

Maxillipede 1, endopod minute, with one apical seta; basis without setae or spines. Maxillipede 2 and 3, endopod rather small, of three segments, with terminal curved spine. Exopods with 4.6.6 setae. Exopod of maxillipede 2 with proximal outer seta very small.

Leg 1 a large biramous rudiment. Leg 5 a large, blunt-ended rudiment. Legs 2–4 absent.

Uropods visible under skin.

Colour: Conspicuously red in eyes, somite 3 and telson, but yellow bands under reflected light. The large dorsal chromatophores have both red and olive-brown branches. No ventral chromatophores in abdomen, but a large richly-branched one at base of maxillipede 3.

#### REMARKS.

It will be noted that this is a quite normal Stage I larva very much like that of *A. dimorphus* (Gurney, 1927). In *A. nitescens* (Lebour, 1932) the first larva from the egg has a rostrum and stalked eyes, but the telson has 7 + 7 setae. It is suggested above that there may be, in that species, a Stage I which moults very soon after hatching into Stage II.

#### Alpheid D. I. (Text-figs. 253–256.)

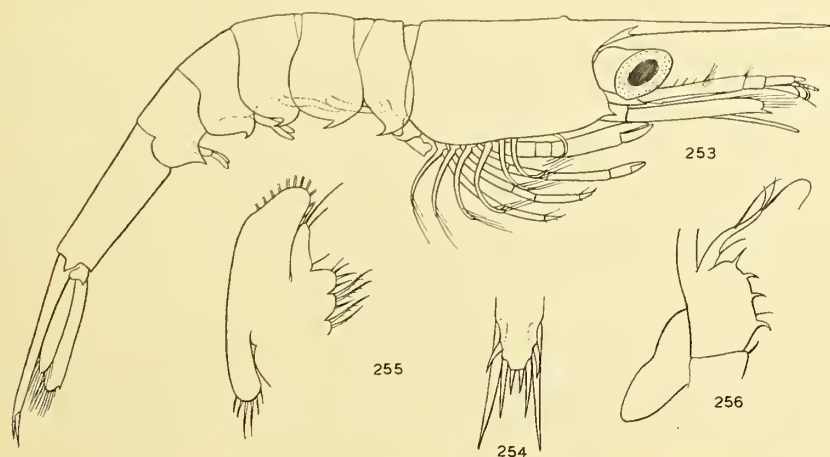
##### LOCALITY.

Discovery Station 1580. 8° 44' S., 41° 50' E.

##### DESCRIPTION.

Length: rostrum 2.85 mm.; rest of body 9.6 mm.

Rostrum longer than antennules, perfectly straight, slightly widened at base, with a marginal tooth on either side (supra-orbital spine). Carapace with median dorsal tubercle and small pterygostomial spine. Abdominal somites with large pleura, each with a



TEXT-FIGS. 253–256.—Alpheid D. I.

FIG. 253.—Last stage ?

FIG. 254.—,, part of telson.

FIG. 255.—Last stage ?, maxilla.

FIG. 256.—,, maxillipede I.

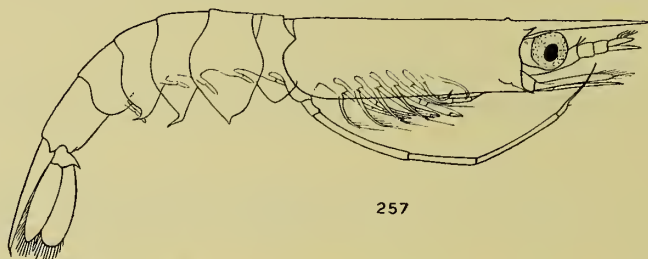


large tooth, recurved on somites 1-4. Somite 6 very long, with posterior lateral triangular projection over base of telson. Telson very long and narrow (2 mm.  $\times$  0.3 mm. at base), without lateral spines, and with 4 + 4 apical spines; outermost spine very large, inserted below a median projection of the telson which bears the remaining six spines. Anal spine absent.

Antennule, peduncle segmented, with stylocerite and minute ventral tooth; endopod longer than exopod, with five segments, the two basal very long; exopod with small distal segment. Antennal scale narrow, with strong apical spine; endopod longer than scale and with basal segment distinct.

Mandible without palp, incisor process toothed. Maxillule well developed, lacinia 2 with four strong spines. Maxilla, exopod with outer margin bare; inner lobes with spines; endopod with small basal seta.

Maxillipede 1 with large bilobed epipod; basis with four strong spines; endopod slender, unsegmented, with long setae; exopod with six setae. Maxillipede 2, endopod of five segments, ischium very short; rudiment of epipod present. Maxillipede 3, endopod of four segments; exopod with 10 setae; rudiment of arthrobranch present.



TEXT-FIG. 257.—*Anebocaris ancyliifer*. "Discovery" Station 704.

Legs 1-4 with exopods; leg 1 with large chela, right chela the larger. Leg 2 long and slender, with chela.

Pleopods present. Exopod of uropods with small spine. Leg 5 lost, but coxa and basis large; coxa with large posterior spine.

#### REMARKS.

This larva is of rather special interest since it so closely resembles *Anebocaris ancyliifer*, Coutière, in its large size, long rostrum and large toothed abdominal pleura. It differs in the form of these pleura, and in the very much shorter carapace and longer abdominal somite 6. For comparison I give a figure of a specimen of Coutière's species of about the same size as the specimen here described (Text-fig. 257). No suggestion can, of course, be made as to the parentage of these remarkable forms, but they do not differ in essentials from the larvae of *Alpheus*, and they may well be found to fall within the genus.

#### Alpheid? D. II. (Text-figs. 258-265.)

##### LOCALITY.

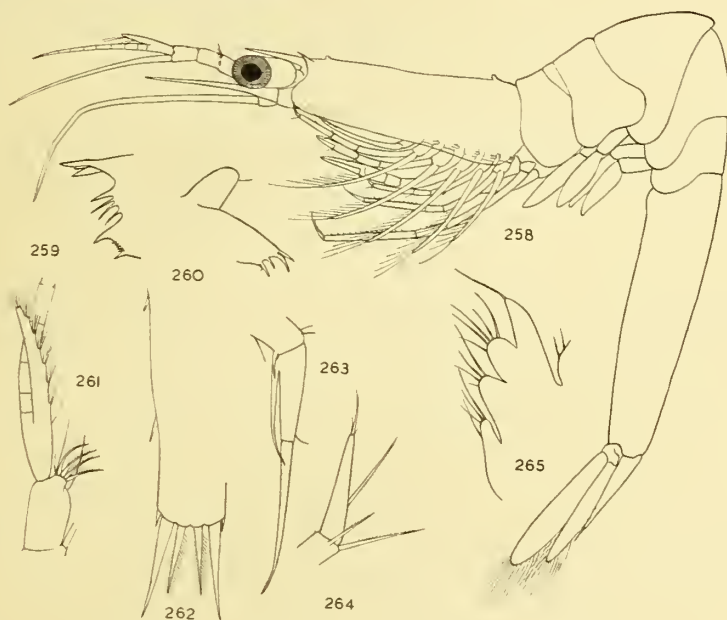
"Discovery"	Station 276	: 5° 54' S., 11° 19' E.	2 specimens.
"	" 277	: 1° 44' S., 8° 38' E.	1 specimen.
"	" 703	: 7° 17' N., 28° 02' W.	3 specimens.
"	" 704	: 3° 37' N., 29° 14' W.	25 "
"	" 705	: 0° 03' N., 30° 36' W.	32 "

## DESCRIPTION.

Oldest stage, length 16 mm.

Carapace narrowing forwards in side view, with anterior and posterior dorsal papillae and supra-orbital spines. Rostrum straight, without teeth. Abdomen bent at somite 3; somite 3 somewhat protuberant dorsally; somite 6 very long, very much compressed laterally and almost knife-like.

Telson deeply hollowed below, nearly four times as long as wide, with two pairs of lateral spines and 3 + 3 apical, the inner pair feathered. In a younger specimen there are 5 + 5 apical spines, of which 2 and 4 are the longest, and are the two long spines of the older stage. Anal spine present.



TEXT-FIGS. 258-265.—Alpheid? D. II.

- |  |  |
|--|--|
| FIG. 258.—Larva of 16 mm. "Discovery" Station 276. | FIG. 262.—Larva of 16 mm., telson (part).    |
| FIG. 259.—,, mandible.                             | FIG. 263.—,, dactyl of leg 5.                |
| FIG. 260.—,, maxillule (part).                     | FIG. 264.—,, ,, ,, 3.                        |
| FIG. 261.—,, antennule (part).                     | FIG. 265.—,, endopod and endites of maxilla. |

Antennule with small rounded stylocerite; outer branch deeply cleft. Antenna, flagellum more than twice as long as scale, which has a very small apical spine.

Maxillule, endopod reduced to a rounded lobe bearing a minute seta. Maxilla, exopod very large, with setae on outer margin; endopod small without basal lobe or seta; three inner laciniae.

Maxillipede 1 with large epipod; basis long and straight; endopod short, broad, unsegmented, or with faintly marked division into three segments; exopod without outer basal setae. Maxillipede 2 with large flat epipod; endopod of five segments; exopod with six setae. Maxillipede 3 with epipod and rudimentary arthrobranch. There are no arthrobranches on the legs, but epipods are present on legs 1-4.

Legs 1 and 2 chelate, leg 2 the larger; exopod of leg 1 with 24 setae. Legs 1-4 with exopods.

Leg 5 much larger than leg 4, slender; dactyl with basal spine.

Pleopods large; pleopod 1, endopod very small, without appendix interna.

## RELATION OF PALAEMONIDAE TO ALPHEIDAE.

Coutière (1899), whose opinion, based upon a profound comparative study of the Alpheidae, is entitled to the utmost respect, concluded that the least modified genera of the family are among the most primitive Caridea, and his comparison with other families led him to the conviction that they were most nearly related to the Hippolytidae. Borradaile (1907) included the Palaemonidae and Alpheidae in his superfamily Palaemonoida, together with the Hippolytidae and Rhynchocinetidae, and at that time he included *Hymenocera* in the Palaemonidae, while *Gnathophyllum* fell within the Crangonoida. Balss (1927) accepted Borradaile's system with the exception that he transferred *Hymenocera* to the Gnathophyllidae, which he retained in the Crangonoida. In most published systems of Caridea there seems to be a tendency to regard the Alpheidae as more nearly related to the Hippolytidae than to the Palaemonidae.

The larva of *Rhynchocinetes* is now known, though not yet described, and has characters which completely exclude it from the Palaemonoida, so that, in considering the position of the Alpheidae it is only necessary to bring the Palaemonidae and Hippolytidae into comparison.

Coutière does not seem to have considered the Palaemonidae as possible near relatives of the Alpheidae although in many, indeed in most, cases the characters to which he draws attention as evidence for Hippolytid affinity would have equal weight if Palaemonidae were substituted for Hippolytidae. The only characters of importance in which the Alpheidae as a whole differ from the Palaemonidae are the presence of epipods on the legs and the segmentation of the carpus of leg 2. Segmentation of the carpus is found in a number of unrelated genera of Caridea and is not of itself a feature of first-rate systematic importance. The absence of epipods from the legs of all Palaemonidae and their presence in most Alpheidae is an important difference, but it loses some of its weight when one recalls that they are also absent in *Synalpheus*, *Cheirothrix* and *Ogyrides* (which Coutière speaks of as "in many respects a true Hippolytid").

The resemblance in general form and in hypertrophy of the chelae of some Pontoniinae to the Alpheidae is very striking, and when one finds one of them (*Coralliocaris graminea*) snapping its claws like an Alpheid, it is difficult to suppose that the resemblance can be entirely a matter of convergence to a similar habitat.

On the basis of adult structure the phylogenetic grouping of the Caridea is exceedingly difficult, and if any evidence can be gathered from the larval phase it should be valuable, though it has not hitherto been taken very seriously.

Attention has already been called (Gurney, 1924, p. 131) to the close resemblance between Palaemonid and Alpheid larvae in some important characters, and a more detailed comparison may now be made in the light of the richer material available.

Apart from the genus *Lysmata* the precocious development of leg 5 and its excessive size are confined to the Alpheidae and Palaemonidae. Within these two families the propod is long and slender and the dactyl usually produced into a long spine, whereas in *Lysmata* the propod is dilated into a paddle-like organ and the dactyl is very much reduced. The great development of leg 4 seen in *Periclimenes* finds something of a parallel in a Lysmatid in which leg 4 has a paddle-like propod as well as leg 5; but the unlikeness in structure and function of these legs in the two types suggests that the disproportion in size and precocious development of leg 5 have been separately acquired. While typical



Alpheid larvae have a very uniform type of styliiform leg 5, there are genera of Alpheidae, just as there are genera of Pontoninae, in which leg 5 is not larger than legs 3 and 4, and it seems likely that there may be two groups within the family of which *Alpheus* and *Synalpheus* would be typical respectively.

The general reduction of the maxillae and maxillipede 1 which characterizes all the Palaemonidae, and is carried to excess in some Alpheidae, is not found in any other families except where development is abbreviated (*e.g.* *Pasiphaea*). Invariably the endopods of the maxillule and maxilla are reduced and unsegmented, and at least the proximal lacinia of the maxilla is absent. In maxillipede 1 the coxa is reduced or scarcely traceable, and the endopod is small and often unsegmented. In the Hippolytidae this reduction does not take place. The endopod of the maxillule may be unsegmented, but it always retains evidence of the loss of segmentation in the presence of one or two setae on its inner margin. The endopod of the maxilla, though it may not be segmented, has a series of three inner lobes bearing setae. The inner laciniae are also well developed, lacinia 2 being distinct, and each bears numerous setae. Lastly the endopod of maxillipede 1 is long, and generally, if not always, shows four segments.

The antenna of Palaemonidae and Alpheidae in Stages I and II has always the exopod distinctly segmented, and there is often, in both families, a peculiar papilla on the inner margin. The endopod is a straight rod bearing a long seta and a small spine. In Hippolytidae the exopod may be unsegmented, or with slight traces of segmentation (*Hippolyte*), or it may be slender and segmented (*Caridion*, *Lysmata*), but there is no inner papilla. The endopod is not the same in the different genera, but it never has the combination of seta and spine seen in Palaemonidae and Alpheidae.

In these two families the exopods in stage I always bear four apical setae symmetrically disposed in two pairs; but in Hippolytidae one seta of the proximal pair is absent so that there are three apical setae, an arrangement which is also seen in *Processa*, *Leptochela* and some, if not all, Pandalidae.

Those who have to discuss the systematics of adult Caridea are commonly forced to rely upon characters which seem to be of very small importance, for example, form of rostrum, shape of the epipod of maxillipede 1, etc. The points of similarity and difference which I have given here are at least positive and unequivocal, and I submit that they suffice to prove that the Palaemonidae and Alpheidae are very closely related, and that they are not nearly related to the Hippolytidae.

This conclusion is based upon consideration of larvae which, although not certainly identifiable, can with some confidence be assigned either to Palaemonidae or to Alpheidae, but the close relation between the two families is shown perhaps most strikingly by the larva described as Alpheid ? D. II. In this case we have a form which, while the salient characters are, on the whole, Palaemonid, has also something of the form of an Alpheid, and a series of epipods exclude it from the Palaemonidae. It is impossible to say to which of the two families it belongs, but it is quite out of the question to refer it to any other family of which the larvae are known.

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